POWER

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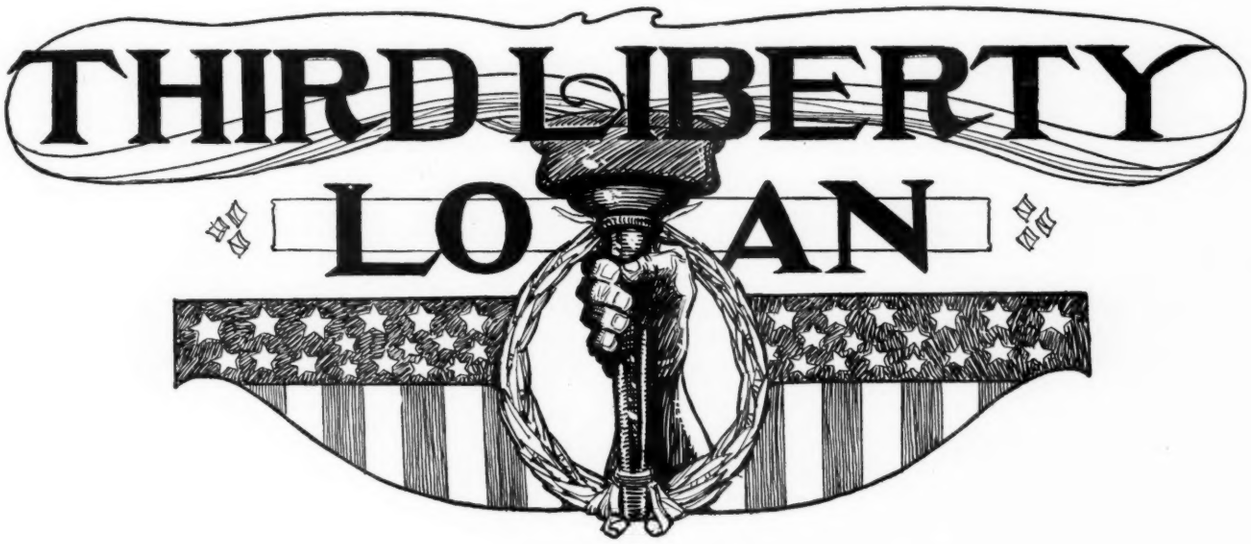


The National Shibboleth

By RUFUS T. STROHM

We've long been a nation of prodigal spenders
With Luxury reigning and Wealth as her slave,
But now we must change to a nation of lenders,
For Uncle Sam needs every cent we can save.
It's time that we exercised judgment and gumption
And gave to our allies a powerful lift
By cutting out waste and decreasing consumption—
The patriot's watchword is personal thrift.

* * *

Because the expense every day runs to millions
In feeding and clothing and arming our men,
We've twice taken loans that were measured in billions,
And now we're required to do it again.
But though it may seem like a burdensome trial,
The end of it all will be certain and swift
If every true citizen learns self-denial—
The secret of winning is personal thrift.

We ought to be proud that the gold we are saving
In office and workshop, at roll-top and bench,
Is spent in behalf of the men who are braving
The hardships and dangers of billow and trench.
Though prices mount higher and war-bills grow longer,
The conflict will have but the shortest of shrift,
And people and nation be better and stronger,
If everyone practices personal thrift.

* * *

The ease-loving habit of "letting George do it"
Is criminal now and must go to the wall;
The country's at war, and to pull bravely through it
The cares and discomforts must rest on us all.
Extravagant ways are a species of treason
From which we should hasten to cut us adrift
And substitute carefulness, saneness and reason—
We'll win if we cultivate personal thrift.

Tamarack Mills Power Plant

BY CHARLES H. BROMLEY

Describes the chief features of the new oil-burning plant furnishing light, heat and power to the Tamarack Mills, Pawtucket, R. I. The plant was designed solely for fuel, has a 2500 kw. extraction turbine, heats the mills with forced-circulation hot water and has the largest atmospheric cooling tower in New England. Unusually interesting performance figures are given.

PERPHAPS no plant is today commanding more attention in New England than that of the new Tamarack Mills, Pawtucket, R. I., the turbine room of which is shown in Fig. 1. Certainly, no engineers were ever prouder of their plant than are Charles Teft, the chief engineer of the plant, and Jencks and Ballou, consulting engineers who designed it. To get a proper perspective of this power house one must go back to 1914, when the plant of the Jencks Spinning Co., alongside the Tamarack Mills plant, was using coal, and to 1916 when oil was introduced as fuel for this plant. With coal the results were:

	Per Ton
Fuel: Crozer-Pocahontas, 14,500 B.t.u., per lb	$4.40
Equivalent evaportation per lb. combustible, lb	12.33
Cost per 1000 lb. steam, cents	18.2

When the change to oil was made, tests in 1916 with oil as fuel gave the following chief results, the costs including operating and overhead charges.

YEARLY SAVING WITH OIL

Weekly kilowatt-hour output	195,400
Yearly kilowatt-hour output	10,160,000
Cost per kilowatt-hour output, exclusive of makeup water, cents	0.588
Cost per kilowatt-hour in 1913 with coal, cents	0.662
Difference 'n cost, cents	0.074
Yearly saving 10,160,000 × 0.00074	$7500

[Those interested who may want further cost and performance data are referred to two articles on this plant by the present writer in *Power* for Dec. 1, 1914, and Dec. 19, 1916.]

So when the Tamarack plant was proposed the management merely needed a contract for oil at a favorable price to immediately decide what fuel it should be built to burn. The management got a price of 92c. per bbl. of 42 gal. of oil, delivered and averaging as following: Moisture, 0.3 per cent.; sulphur, 3.56 per cent.; sediment, trace; specific gravity, 0.960; Baumé gravity, 15.9; flash point (closed cup), 178 deg. F.; fire point (open cup), 262 deg. F. The oil is a Mexican product. No one hopes now to close a long-term contract at this price. There is a 257,500-bbl. oil-storage station at Providence a few miles away, and oil from here is delivered to the Tamarack plant in cars.

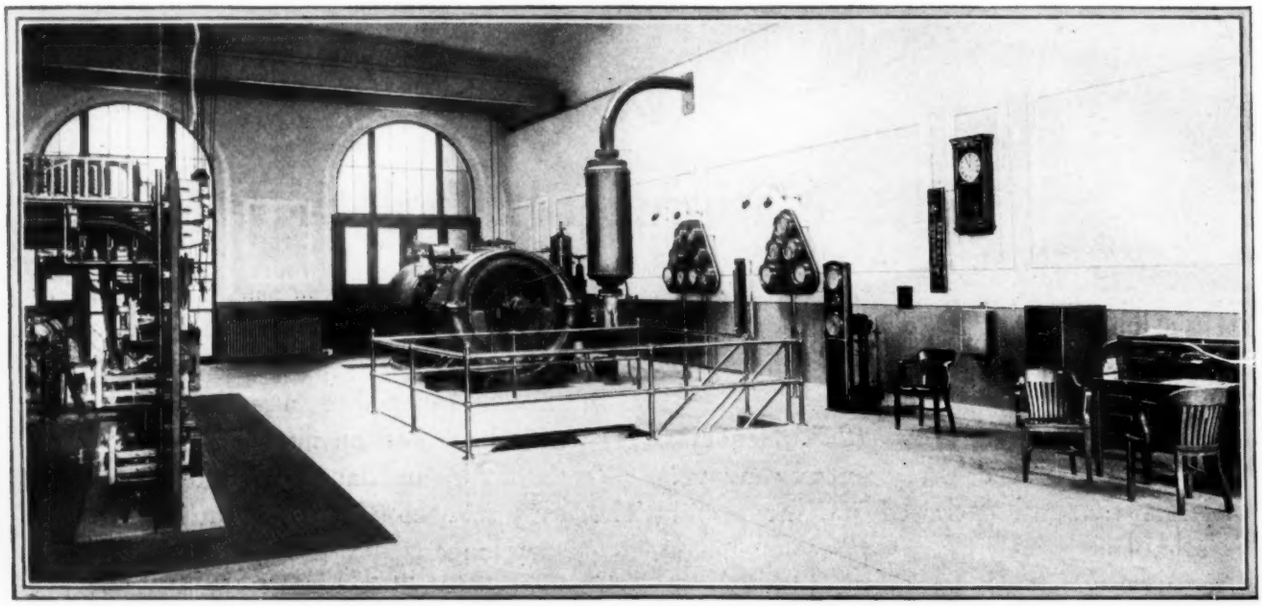


FIG. 1. VIEW OF TURBINE ROOM, TAMARACK MILLS, PAWTUCKET, R. I.

Now that the Fuel Administration controls fuel oil, one is interested to know how the contract is affected. Well, the mills are making Government war goods, and timely and adequate delivery is reasonably well assured at the contract price. The plant was designed for oil exclusively, no coal or ash-handling equipment being installed.

The Tamarack plant consists of four water-tube boilers (B. & W. type) set with the bottoms of the front tube headers 8 ft. above the floor. Fig. 2 is a view of the boiler room. There are two furnace doors per boiler, and at each is a steam atomized (Hammel) oil burner, giving one burner for every seven tube headers. The burner produces a flat flame by reason of the impact of oil upon a renewable steel plate in each burner tip. Two oil-storage tanks, each of 24,000 gal. capacity, are used, the contents being kept at 115 deg. F. by live steam from the boilers admitted through

reducing valves to pipe coil heaters in each tank. Exhaust steam from the oil-pumping outfit gives the oil a temperature of 160 deg. F. at the burner. This is 18 deg. F. below the flash point of the oil. The usual furnace draft carried is 0.2 in., the best boiler rating 40 to 50 per cent. above builders' rating, and the evaporation from and at 212 deg. F. per lb. of oil averages 15 pounds.

Throughout the plant the piping is one of the finest jobs the writer has ever seen. By great care in drawing up the specifications, the cost for extras was less than 1 per cent. of the total cost of the piping. A 16-in. lap-welded steel steam header is connected to the boilers by two 90-deg. bends (6-in. pipe) of 4 ft. radius each, having a nonreturn valve between each bend. Fig. 5 shows the exhaust piping at the spiral riveted free exhaust pipe.

All auxiliary exhaust is led to a 10-in. cast-iron main supplying exhaust steam to a closed feed-water heater of 900 sq. ft. heating surface. From the feed-water heater the 12-in. wrought-iron auxiliary exhaust main is continued to a back-pressure valve and then to the 24-in. spiral riveted free exhaust pipe. A tilting trap pumps water to a feed tank, from which the heated water enters the pump suction main. Two feed pumps are used, one a duplex 10 and 7 x 12-in., the other a three-stage centrifugal. The 6-in. discharge main is of cast iron and has a 4 x 1¼-in. venturi tube inserted in it. The branches to the boilers are of brass, and each branch has a "drop" pipe leading to each drum of each two-drum boiler. To avoid shock and pulsating flow, which would disturb the accuracy of the venturi feed-water meter, a large cast-iron air chamber is placed in the discharge main between the venturi tube and the pumps. Two-inch brass globe valves are used for controlling the feed to each boiler. The feed to the boilers averages 190 deg. F.

The feed-water tank receives the condensate from the surface condenser attached to the main unit, also water from the turbine bearings and from the various drains throughout the plant. Fig. 3 is a view of the auxiliaries room.

The main four-stage turbine is of the extraction type, 2500 kw., 3600 r.p.m., 155 lb. steam pressure. Steam is bled from the second stage at from 1 to 10 lb. gage pressure for heating the water used for heating the mill buildings. More about the hot-water heating system later. The turbine is served by a surface condenser of 5000 sq.ft. As no adequate cheap water supply is available for condensing purposes an atmospheric cooling tower 20 ft. wide, 120 ft. long and 35 ft. high, handling about 5000 gal. of water per minute during cool weather, is used. The 12-in. circulating pump is of 4500 gal. per minute capacity, driven by a 95-hp. two-stage turbine. The discharge water goes to the cooling tower through an 18-in. pipe and returns to the pump suction through one of the same size. This tower has not yet had an opportunity to show what it can do under summer conditions, but judging what it will do based on winter operation, in the way of vacuum and cost of handling water, all concerned are indeed enthusiastic, especially Jencks and Ballou, the consulting engineers who designed the plant. The recording instruments are well arranged, as shown in Fig. 4. The main water connections to the tower are shown in Fig. 6.

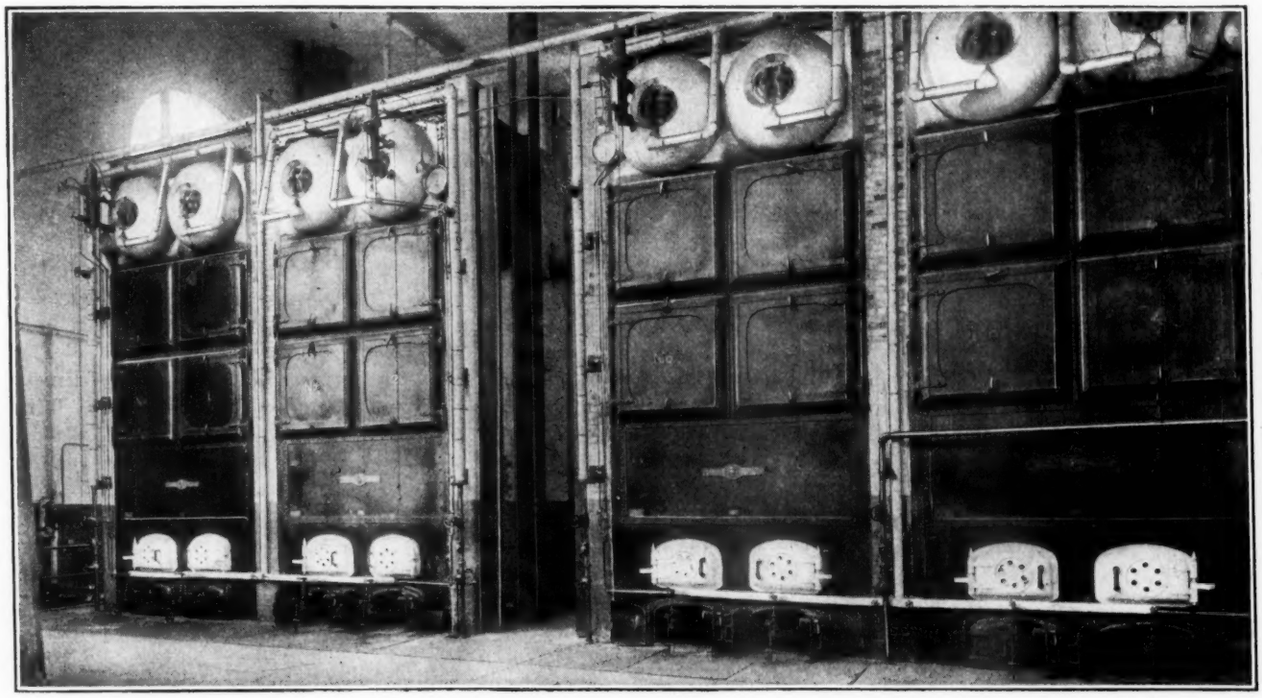


FIG. 2. OIL-BURNING BOILER ROOM, TAMARACK MILLS

The hot-water heating system is of considerable interest. Exhaustive investigations led to a decision between a vacuum steam heating system and forced hot-water circulation. The successful company bid on both, but guaranteed appreciably better economy for the hot-water system. The contract was awarded for the latter system. The essential facts are these: The mill is devoted chiefly to cotton spinning, and the main mill, of red brick, is 368 ft. long by 172 ft. wide, has four

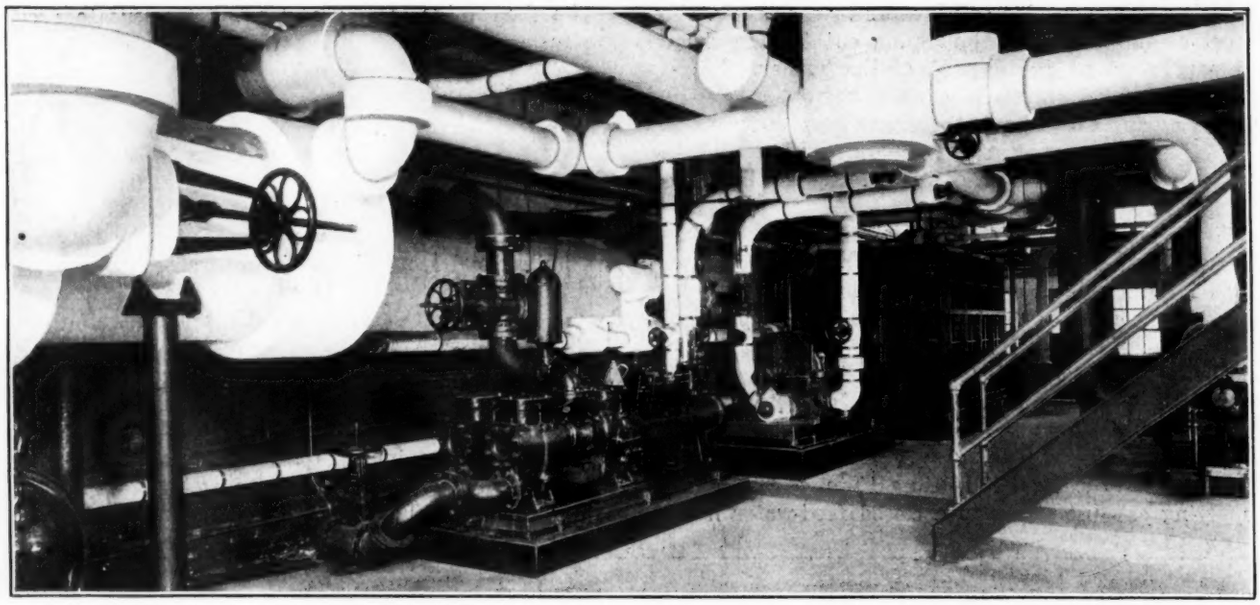


FIG. 3. ONE SIDE OF THE AUXILIARY ROOM, SHOWING PIPING AND FEED PUMPS

stories and a basement. The stories are high, ranging between 18 and 19 ft. The height of the basement varies between 8 ft. 8 in. and 13 ft. 8 in. The total floor area of the mill, including the basement, is 334,500 sq.ft., and the cubical content, including basement, is 5,720,000 cu.ft. Glass area, 43,320 sq.ft.; wall area, 40,000 sq.ft.; skylight area, 3870 sq.ft. These include three toilet towers. The radiating surface totals 22,800 square feet.

At the south end of the mill is a storehouse adjoining the power house. This structure is 78 ft. long by 172 ft. wide, the stories 9 ft. each except the first, which is 18 ft.+. The floor area is 47,200 sq.ft.; volume, 629,600 cu.ft.; glass area, 1980 sq.ft.; wall area, 6760 square feet.

For the mill, the ratio of heating surface to volume in cubic feet averages 1 to 251. The ratio varies of course for different parts of the mill, but ranges from 1 to 155 for the top story to 1 to 434 in the basement.

For the storehouse, the average ratio of radiating surface to cubic-foot volume is 1 to 547.

The radiating surface in the buildings is of 1¼-in. pipe in coils distributed overhead and on the walls beneath windows.

The main pipes extend from the mill through the storehouse and into the power house, where connection is made to the circulating pump. The latter unit is situated in the basement of the power house. The pump is of special design for this job and is direct-connected to the steam turbine. The pump has a 6-in. suction and a 5-in. discharge, and maintains a differential pressure between the suction and discharge of 25 pounds.

The steam turbine is supplied with steam at 150 lb. pressure and exhausts at a back pressure ranging from 1 to 5 lb. The exhaust from the turbine is led to the heater located in the storehouse. This is a straight tube heater of special design for this job, with capacity

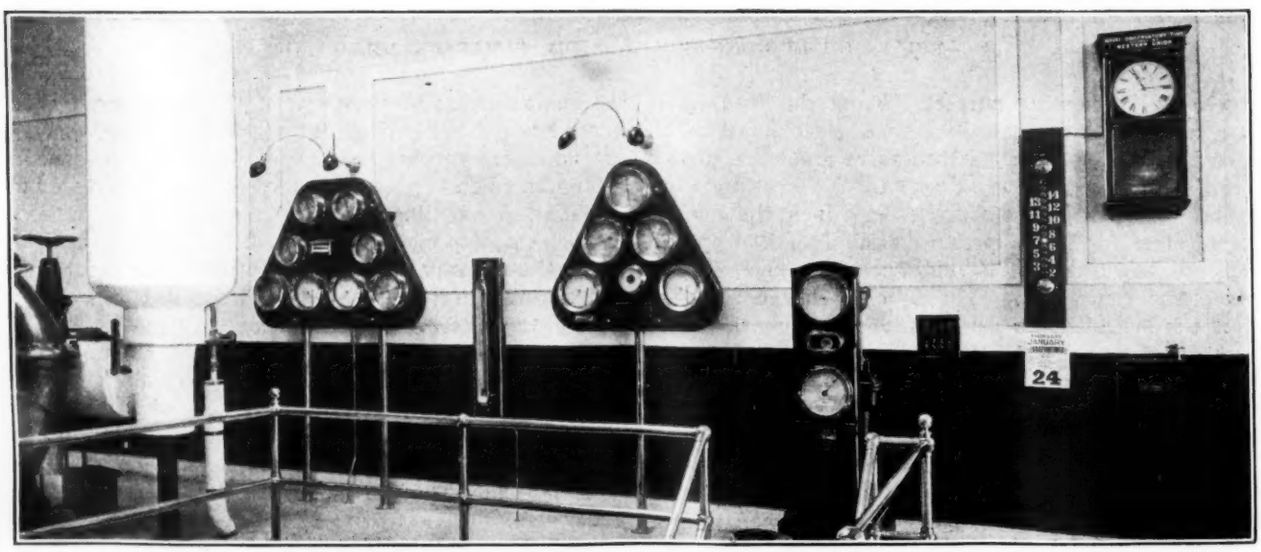


FIG. 4. UNUSUALLY GOOD ARRANGEMENT OF RECORDING INSTRUMENTS

to maintain the flow temperature of water to any desired temperature ranging from 100 to a maximum of approximately 210 degrees.

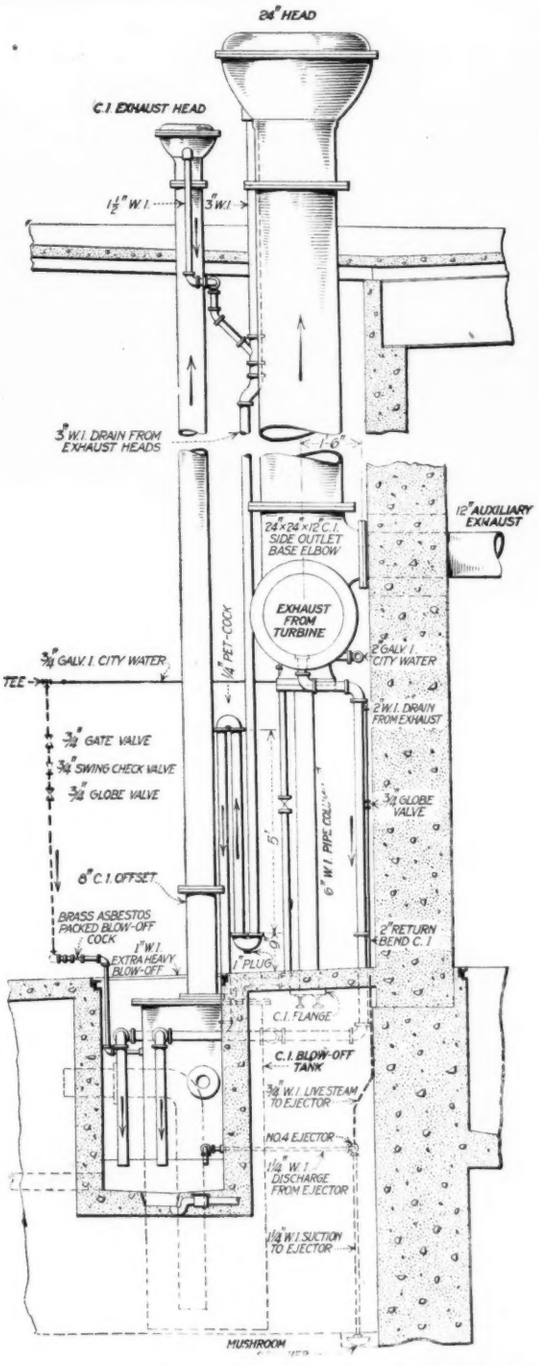


FIG. 5. EXHAUST AND BLOWOFF CONNECTIONS

The exhaust from the hot-water circulating pump turbine is also connected to the heater and there is a live-steam connection for use when the main turbine is not running. The hot-water circulating pump turbine is designed to give full capacity with steam pressure as low as 70 lb. Thus the boilers at night or on Sundays may vary in pressure considerably without interfering with the proper heating of the mill. The governor of this turbine is equipped with thumb-screw adjustment that will vary the speed of the pump from zero to maximum. In this way more or less water can be circulated, according to the flunctuating demands occasioned by the weather conditions.

The volume and pressure of the steam supply to the heater is controlled by hand to conform to the demands of the work in the mill, and to the outside temperature and other conditions. The pipe used is wrought steel. Long-turn fittings were used where the friction conditions made this advisable, but regular

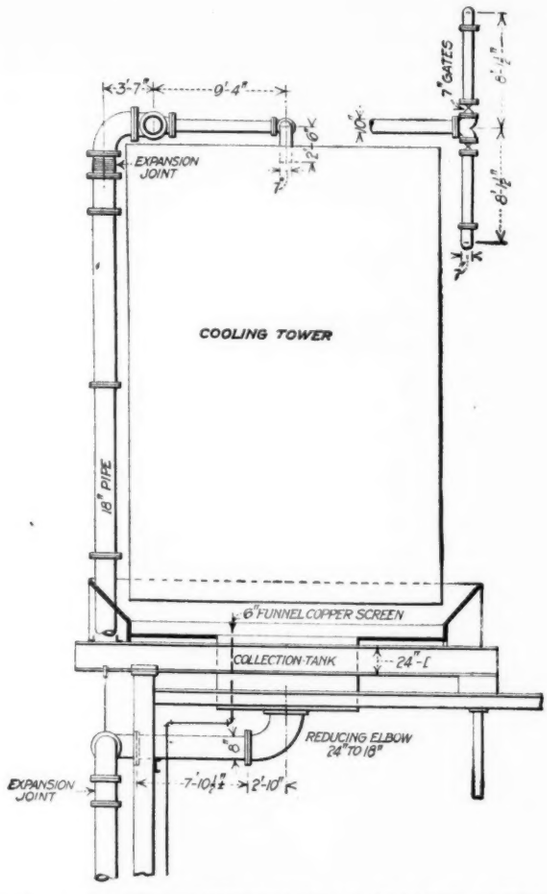


FIG. 6. WATER CONNECTIONS AT COOLING TOWER

PRINCIPAL EQUIPMENT OF TAMARACK MILLS PLANT, PAWTUCKET, R. I.

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
4	Boilers	Water-tube	400-hp.	Steam generation	150-lb. pressure	Babcock & Wilcox Co.
1	Turbine	Extraction	2500-kw.	Main unit	150 lb., 29-in. vacuum, 5-lb. extraction	General Electric Co.
1	Exciter	Turbine-driven	35-hp.	Main-unit excitation	3,600 r.p.m., 280 amp., 125 volts	General Electric Co.
1	Exciter	Motor-driven	50-hp.	Main-unit excitation	1,200 r.p.m., 48 amp., 125 volts	General Electric Co.
1	Condenser	Surface	5,000-sq.ft.	Main unit	Cooling tower water	C. H. Wheeler Mfg. Co.
1	Cooling tower	Atmospheric	20 x 35 x 120 ft.	Main-unit condenser	Atmospheric	C. H. Wheeler Mfg. Co.
1	Pump	Centrifugal	350-g.p.m.	Boiler feed	Lea-turbine-driven	Platt Iron Works
1	Pump	Reciprocating	10 x 7 x 12 in.	Boiler feed	150-lb. pressure	Platt Iron Works
1	Oil-burning Equipment, Complete	Steam		Oil for boiler purposes		Hammel Oil Burning Equip. Co.
1	Heater	Closed	900-sq.ft.	Feed-water heating	Exhaust from all auxiliaries	C. H. Wheeler Mfg. Co.
1	Heater	Closed		Mill-heating system	Extraction steam for main turbine	General Fire Extinguisher Co.
	Heating system	Hot-water		Heating mills	Forced circulation	General Fire Extinguisher Co.
1	Pump	Centrifugal	725 gal. per min.	Hot-water circulation	1,550 r.p.m., 54-ft. head	Goulds Mfg. Co.
1	Turbine	Steam		Hot-water pump drive	1,550 r.p.m.	D. E. Whiton Machine Co.
1	Turbine	Steam		Feed-pump drive	2,800 r.p.m.	D. E. Whiton Machine Co.
1	Meter	Venturi	4-in.	Feed water		Builders Iron Foundry Co.
1	Switchboard	Direct-control				General Electric Co.

fittings were used to a great extent, especially on the smaller sizes of pipe.

The system was designed to guarantee the following temperatures with outside temperature at 5 deg. below zero: Main mill, 65 deg.; toilet towers, 55 deg.; opening room, 60 deg.; storehouse, 40 degrees.

In the severe weather of this winter, with the temperature often lower than 10 deg. below zero, this system maintained satisfactory temperatures, thus exceeding the guaranteed temperatures.

Uniform circulation has been produced without any changes in the design of the piping since the system was first started.

This plant is commanding the attention of all New England, particularly that of the textile industry. Its performance portends much for the future of fuel oil in New England.

The water, light and power industry in January had 6 per cent. more employees and paid 5 per cent. more wages than in December. As compared with the corresponding month of one year ago, the group as a whole reported in January, 1918, an increase of 13 per cent. in the number of employees and 27 per cent. in wages.

In a paper read recently at Chicago, Major R. A. Millikan, professor of physics in Chicago University, stated that war was 85 per cent. science and engineering and 15 per cent. actual fighting. As one application of science he mentioned that it had proved practicable to locate the position of a heavy gun within 50 ft. by observations on the sound waves set up on its discharge.

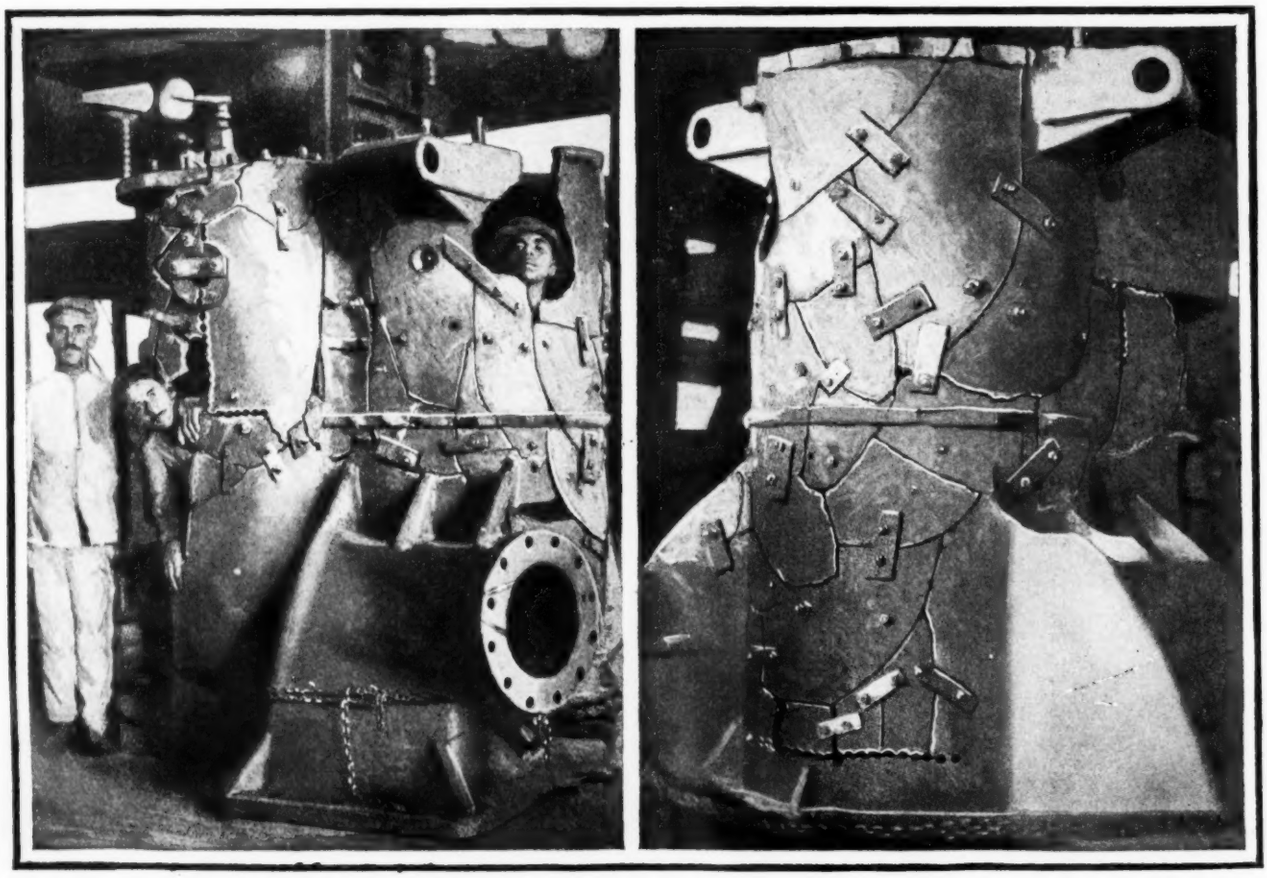
Kultur Mit Sledgehammer

The illustrations, reproduced from *Engineering* (London), show the damaged high-pressure cylinders of one of the German merchant ships interned in Brazil and illustrate the thoroughness of German destruction.

The 45 vessels which are interned, totaling 235,000 gross tons, had all been more or less seriously damaged, particularly the propelling machinery. In some cases new cylinders throughout had to be made; in others only portions of the cylinders had been destroyed. In one instance nearly 8000 holes must have been drilled in order to effect complete destruction. As it was found that the repair work could be carried out in the naval arsenal of Brazil, it was decided by the Ministry of Marine to proceed immediately with the recasting of the damaged cylinders and liners, and great credit is due to the engineering officers of the Brazilian Navy and to the personnel of the arsenal, not only for executing the work, but for the expedition with which it was carried out.

The cylinders illustrated had been broken into hundreds of small pieces, and in order to make new cylinders to suit the set it was necessary to assemble as many pieces as possible so that their dimensions could be measured accurately.

It is an interesting fact that most of the broken parts of the machinery were carefully stored between decks, evidently in order to be used as scrap in Germany in the event of the return of the ships to the "Fatherland."

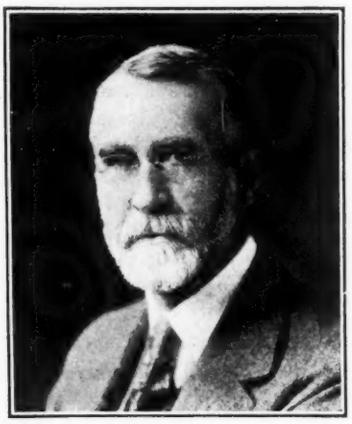


WHAT "SCHRECKLICHKEIT" DID TO AN INTERNED GERMAN STEAMER IN BRAZIL

Distinguished Engineers of New England

New England is the home of many distinguished engineers. It was there that George H. Corliss made his engine, which became a famous type. E. D. Leavitt, of Boston, had become a distinguished engineer before he died, and among the boys that Leavitt had in his office some are today holding positions of appreciable magnitude. Edwin Reynolds, who designed the last of the great reciprocating engines, was a New Englander. And there are so many others who have "drunk their cup a round or two before and one by one crept silently to rest" that it is regrettable that space here does not permit of saying something about them and others, who, fortunately, are living. There follow brief sketches of some engineers in New England who are well known for their interest in and contributions to the art.

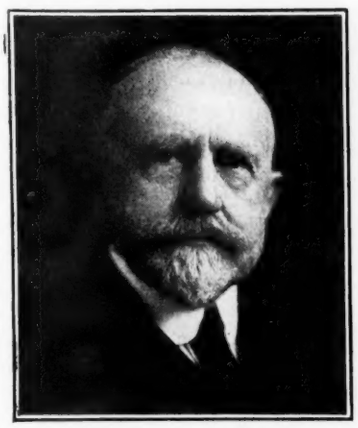
CHARLES T. MAIN, Boston, President of the American Society of Mechanical Engineers, was born in Marblehead, Mass., Feb. 16, 1856. He is a graduate of the Massachusetts Institute of Technology, and after graduation was an assistant in the department of mechanical engineering in that institute. In the late 70's he became draftsman for the Manchester Mills, Manchester, N. H. Later he became engineer for the Lower Pacific Mills, Lawrence, Mass.; in 1886 he became assistant superintendent, and in July, 1887, was made superintendent.



CHARLES T. MAIN

In all Mr. Main put in eleven years in these mills, having charge of all engineering and of the reorganization and operation of the mechanical department. After a year in Providence, R. I., he formed an association with F. W. Dean, whose photograph, by the way, should appear here were it not that Mr. Dean is serving the Government and unavailable at this writing. These engineers became famous for their textile-mill work, which later extended to general engineering. The association lasted for fourteen years, or from 1893 to 1907. The small waterwheel installations grew to great hydro-electric projects. Mr. Main has engineered four hydro-electric developments aggregating 280,000 hp. for the Montana Power Co. He is president of the Engineers' Club, Boston; member of the American Institute of Consulting Engineers; Boston Society of Civil Engineers, and other technical societies. He became a member of the American Society of Mechanical Engineers in 1885, served as manager for three years, and was elected president at the last yearly meeting in December, 1917. He has long been active in public life. As president of the American Society of Mechanical Engineers he is sure to play a laudable part in America's war against the Hun. The society has been called upon by the Government to assist in solving many knotty problems related to the war, and it is fortunate that a man of Mr. Main's capacity and experience is guiding the society through these propitious times for the engineer.

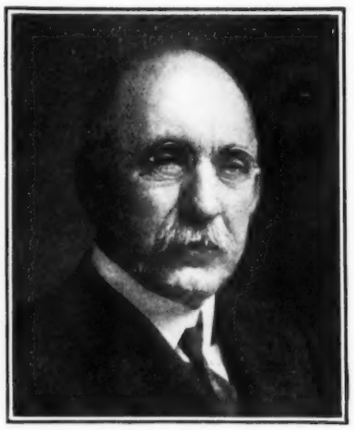
JOHN R. FREEMAN, Providence, R. I., is, perhaps, New England's most distinguished engineer. Born in West Bridgeton, Me., July 27, 1855, he graduated from "Tech" in 1876. In 1904 Brown honored him with the degree of Sc.D., and Tufts' did the same in 1905. From 1876 to 1886 he was engineer with the Water Power Co., Lawrence, Mass.; from 1878 to 1886 assistant consulting engineer to Hiram F. Mills, and for the following ten years chief engineer, Associated Factory Mutual Insurance Co.



JOHN R. FREEMAN

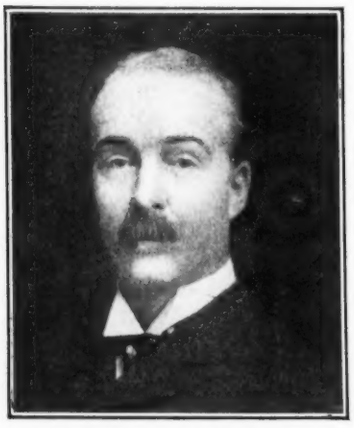
He was also consulting engineer on water supply and mill construction for various corporations and for New York, Boston, Los Angeles, Baltimore and San Francisco. He was civilian engineer, Supplies Board, War Department, in 1902; advised on the Panama Canal locks and dams and for the Canadian government on water-power conservation. He is trustee of the Massachusetts Institute of Technology; was president (1893), Boston Society of Civil Engineers, vice president (1902), American Society of Civil Engineers, president (1905), American Society of Mechanical Engineers, member Providence Chamber of Commerce and fellow of the American Academy of Arts and Sciences. In 1899 he made extensive investigations of New York City's water supply; he was chief engineer of investigations for the Charles River Dam, Boston Harbor, in 1903, and in 1903-4 was consulting engineer on drainage and sanitation for the Boston Metropolitan Park Commission. He planned the hydro-electric development on the Feather River, Calif., in 1905, also developments along the St. Lawrence and Long Sault. He was in charge of the water-power investigations of the New York State Water Supply Commission. At one time he was a member of the Water Commission of Winchester, Mass. Mr. Freeman has always been active in general business and financial matters, being president of the Manufacturers, Rhode Island, Mechanics, State, Enterprise and the Associated Factory Mutual Insurance Companies; director Rhode Island Trust Co., Providence Gas Co.

DR. IRA N. HOLLIS, Worcester, Mass., is the President Wilson of the American Society of Mechanical Engineers. His utterances when president of the society are full of the same lofty, substantial vision and comprehension of events in engineering as President Wilson's are of the changing social fabric. Born in Mooresville, Ind., 1856, he graduated from the Louisville, Ky., high school, took up the machinist's trade and later entered the United States Naval Academy. He served on cruisers "Quinnebang," "Alert," "Hartford," "Richmond" and "Charleston." In 1884 he was a member of the advisory board that designed the ships of the famous White Squadron. Following this he served under the late Admiral Melville, chief engineer, United States Navy. In 1893 he resigned to become professor of engineering, Harvard University, where he remained for twenty years or until he became president of Worcester Polytechnic Institute. Since the outbreak of war Dr. Hollis has been of most valuable assistance to his Government in engineering problems of the war.



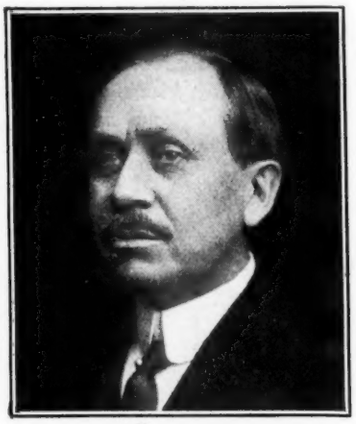
DR. IRA N. HOLLIS

PROF. EDWARD F. MILLER is one of the most widely known men in the field of power-plant engineering. He is head of the Department of Mechanical Engineering, Technology, which department is maintained by Harvard University and the Institute; he is also director of the engineering laboratories of "Tech," from which he graduated in 1886. He planned the greatest part of "Tech's" new engineering laboratories. He is a master at harnessing theory and practice to give the best teamwork. The engineer officers now instructed by him for the Shipping Board's merchant marine will swear to that. He is author of valuable engineering literature. Professor Miller is a member of the American Society of Mechanical Engineers, American Society of Refrigerating Engineers, American Society of Civil Engineers, American Academy of Arts and Science, Boston Society of Civil Engineers, and honorary member of the National Association of Stationary Engineers. He is Chief Instructor in Engineering for the Shipping Board, member Boiler Code Committee.



PROF. EDWARD F. MILLER

GEORGE HALE BARRUS, of Boston, is closely identified not only with the development of power as applied particularly to the textile and paper industries of New England, but with its development nationally. He is a graduate of the class of '74, Massachusetts Institute of Technology. Mr. Barrus has conducted investigations and experiments in steam engineering for the United States Navy and for marine purposes generally. Under the late and well-known Prof. Channing Whitaker he supervised the erection of the steam-engineering laboratory of old Technology, the first of its kind in the United States. His works on boiler and engine tests are known internationally, and he is chairman of the power-test committee of the American Society of Mechanical Engineers. Mr. Barrus was vice president and member of Council of that society from 1905 to 1906; is a member of the Boston Society of Civil Engineers, New England Water Works Association, Society of Naval Architects and Marine Engineers, Bostonian Society, Engineers' Club of New York and the Technology Club.



GEORGE H. BARRUS

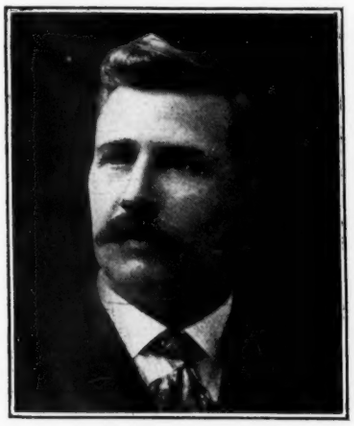
JOHN A. STEVENS, Lowell, Mass., was born in Galva, Ill., 1868. He left school at the age of 7, but later graduated from the East Saginaw, Mich., high school, and spent a year at the University of Michigan. He served as machinist in the Pere Marquette Railroad shops, and as engineer on the Lake steamers, "Sappho," "Byron Whittaker," "W. H. Stevens," "Roman" and "Cambria." At 27 he held a marine engineer's unlimited license, and was engineer on the ocean steamships "Indiana," "Illinois," "New York," "St. Louis" and "St. Paul." In 1896 he became chief engineer, Merrimack Manufacturing Co., Lowell, appointed to the Massachusetts Board of Boiler Rules by Governor Curtis Guild in 1907, reappointed by Governor Draper in 1910, studied European engineering practice in 1909 and later engaged in consulting work, appointed chairman Boiler Code Committee, A.S.M.E., in 1911, and to his dynamic personality the Code owes much for its success. He was one of the early users of stage and exhaust steam from turbines; one of two inventors of a 25,000 hp. water-tube boiler.

JOHN A. STEVENS

I. E. MOULTROP, Boston, widely known in engineering circles, began his career as an apprentice machinist with the Whittier Machine Co., later to become that company's chief draftsman. Twenty-six years ago he resigned this position to go with the Boston Edison Co., with which he has served ever since. His first job with the Edison company was to lay out and install the steam equipment for the old Atlantic Avenue Station, commonly known as the third station. Since then he has grown with the development of power generation and transmission. For some years he has been assistant head of the construction bureau of the Edison company, directly responsible for work of all character on power stations, substations, office buildings, etc., and indirectly responsible for the construction of the transmission lines, underground and overhead. Mr. Moultrop has been manager and vice president of the American Society of Mechanical Engineers, and for five years was chairman of the membership committee of that society; he also serves on the Boiler Code Committee. He is a prominent member of the National Electric Light Association.

I. E. MOULTROP

GEORGE A. LUCK, chairman, Massachusetts Board of Boiler Rules and chief of the commonwealth's Boiler Inspection Department, was born in London, Eng. He served his apprenticeship to the machinist's trade there, and when a young man came to America. One of his first jobs was as watch engineer in the old Boston Electric Light Co. That was when the electrical industry was still in swaddling clothes. Later, he was engineer for the Reece Buttonhole Machine Co., Boston, the Franklin Brewery, Boston, and later became engineer for the Hamilton Mills, Amesbury, Mass. Following this he went to Chicopee to take charge of the power plant of the Dwight Manufacturing Co. In 1906 he took the civil-service examination for state boiler inspector, and in September, 1907, was appointed, together with five others, a law having passed the legislature increasing the number of inspectors from ten to fifteen. Joseph McNeil was then chairman of the Board of Boiler Rules and chief boiler inspector. Mr. Luck was assigned to the district embracing the suburbs of Boston. In July, 1912, he became acting chief and chief in June, 1914.

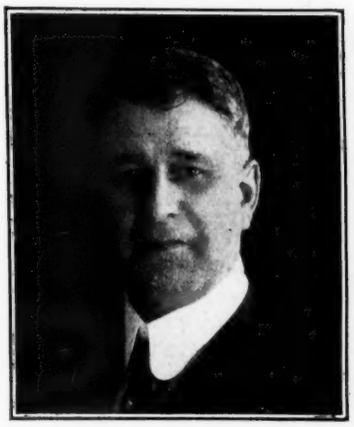


GEORGE A. LUCK

WALTER A. DIMAN, Manchester, N. H., is the son of George H. Diman, consulting engineer, American Woolen Co. Born in Woonsocket, R. I., 1879, he was educated in the public schools, Lawrence, Mass.; entered the Naval Academy, Annapolis, September, 1898, graduated in 1902; performed service in the Navy at the Asiatic Station from 1902 to 1905, when he returned for duty at the Bureau of Steam Engineering, Navy Department, Washington, D. C. After a tour of duty here he was detailed as engineer officer of the President's yacht "Mayflower," returning to duty at the Bureau of Steam Engineering; detailed for duty at the Naval War College, Newport, R. I., and then transferred in 1910 as engineer officer of the U. S. S. "New Jersey." He resigned from the Navy October, 1911, to become superintendent of power, Amoskeag Manufacturing Co., Manchester, N. H. He is a member, American Society of Mechanical Engineers, the American Society of Naval Engineers and belongs to several clubs.

WALTER A. DIMAN

WALTER H. DAMON, superintendent of power generation, United Electric Co., Springfield, Mass., typifies the purposeful, persistent New Englander. Compelled to face the world practically alone before he could with dignity wear long pants—at 11, to be exact—he has fought a long fight, and won. Like most boys whom the Fates have cast up and would make of them derelicts, young Damon tried his hand at various things until one momentous day he got a job wheeling coal into the little boiler room of the United Electric Co. That was twenty-six years ago. He had not been on the job long before he got his hands on—well, it was a copy of *Power*. Friend Walter says the world unfolded. Mr. Damon is a member of several engineering societies, including the American Society of Mechanical Engineers and the National Electric Light Association. He has held most of the chief offices in the National Association of Stationary Engineers; he was elected national president of this association in 1915.

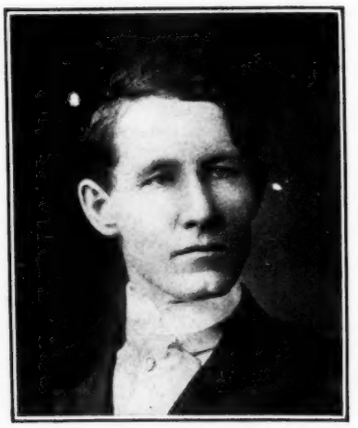


WALTER H. DAMON

FRANK W. TOWNSEND, of Providence, R. I., is a chief operating engineer of the new school. Born in the country, he was always fascinated by the blacksmith shop and the thumping engine down at the old stone mill. He laid the foundation for ability as an operating engineer by getting machine-shop experience at the start. He attended night school and studied hard the few engineering books that came his way. Then came a job in a machine shop doing marine work. Of course he soon went to sea, started somewhere in the stoke-hole and after seven years had his marine chief engineer's unlimited license and commanded the mechanical equipment of a large ship. Not that swimming through bilge-water to start a balky pump took the romance from a ship's engine room, no, that is what gives it; but the shore had a stronger call. He is now chief engineer of the famous South Street Station, Narragansett Electric Lighting Co., Providence, an 80,000-kw. turbine plant having a 45,000 kw. compound turbine.

FRANK W. TOWNSEND

EDWARD H. KEARNEY is one of the best-known operating engineers in New England. Born in North Billerica, Mass., he graduated from the Howe Academy there, later serving three years as apprentice machinist. His apprenticeship served, he put in four years as journeyman and erecting engineer, and completed the four-year course in mechanical drawing in the night schools of Boston. He served as instructor in steam engineering for three years in Franklin Union, Boston. He held the position of assistant chief engineer for the Jordan Marsh Co.'s large department store, Boston, and for twenty years he has been chief engineer for the John Hancock Mutual Life Insurance Co. In the N.A.S.E. he has held the following important offices: state deputy for Massachusetts, chairman state educational committee, national vice president in 1911, national president in 1912 and secretary of the national educational committee in 1913, 1914, 1915 and 1916. Mr. Kearney has contributed largely to the technical press.



EDWARD H. KEARNEY

New England's Water Power

Most of the interesting figures relative to New England's water power which follow are given by Henry I. Harriman, of Chace & Harriman, Boston: In New England there are eight large rivers having considerable fall: Penobscot, 1500 ft.; Kennebec, 1000 ft.; Androscoggin, 2200 ft.; St. Croix, 400 ft.; Saco, 1900 ft.; Merrimac, 269 ft.; Connecticut, 2000 ft. and the Housatonic with 900 ft. These rivers drain 35,000 of the 60,000 square miles of New England. The Bureau of Corporations estimates that 600,000 hp. of water energy is now in use in New England and that these same developments can be improved to give 200,000 hp. additional. The minimum water power capable of development is placed at 1,000,000 hp., with a possible 2,000,000 hp. In developed and undeveloped water power Maine has nearly 1,000,000 hp.; New Hampshire, Vermont and Massachusetts, 200,000 to 300,000 hp. each; Connecticut, 160,000 hp. and Rhode Island, 16,000 hp.

The present water-power developments in New England total more than two billion kilowatt-hours.

Most large New England streams vary greatly in their maximum and minimum flow. At the Vernon plant, Connecticut River Power Co., the variation is from 1500 cu.ft. per sec. to 150,000 cu.ft. per sec., or 100 times the minimum. The extremely low flow occurs on relatively few days, and in an average year the plant has sufficient water to carry full load for nine months.

Among the large hydro-electric developments in New England are the plant of the Rumford Falls Power Co., on the Androscoggin at Rumford, Me.; the plant of the Androscoggin Power Co., on the same river, near Lewiston; the plants of the Cumberland County Power and Light Co., on the Saco River, near Portland; the plants of the Bangor Railway and Electric Co., near Oldtown and Ellsworth; the plants of the Central Maine Power Co., near Waterville; the plant of the Turners Falls Co., on the Connecticut River at Turners Falls, Mass.; the plant of the Connecticut Power Co., on the upper Housatonic; the plant of the Connecticut River Power Co., on the Connecticut River near Brattleboro; and the plants of the New England Power Co., on the Deerfield River. These various plants have an aggregate capacity of about 250,000 hp. Nearly all of them have been constructed within the last five years and indicate the rapidity with which our streams are being utilized and their energy transmitted to distant cities and towns.

Considerable progress has also been made in the development of storage and the consequent conservation of the flood waters of the spring. A dam at the outlet to Moosehead Lake impounds a total in excess of thirty billion cubic feet and is capable of more than doubling the minimum flow of the Kennebec River at Augusta. Storage reservoirs on the Rangeley Lakes and in the upper waters of the Androscoggin have assured a minimum flow of 2000 sec.-ft. at Rumford Falls and Lewiston, and a reservoir created in Somerset, Vt., is now storing enough water to produce in existing plants approximately 25,000,000 kw.-hr. which would otherwise be wasted.

Training Engine-Room Crews for America's New Ships

By HENRY HOWARD

Director of Recruiting Service, United States Shipping Board, Custom House, Boston.

WITH the recent putting into commission at Boston of the first of a squadron of training ships for training men to man the new Government-owned cargo fleets, the United States Shipping Board Recruiting Service has greatly increased its activities. It is planned to train 25,000 Americans, 21 to 30 years old, for sailors, firemen, coal-passers, oilers, watertenders, cooks and stewards in the new merchant marine.

There are now two training ships in commission at Boston, the "Calvin Austin" and the "Governor Dingley," formerly in the coastwise passenger trade. Each is a 3800-ton ship, having reciprocating engines of 2700 hp. Each ship accommodates from 500 to 600 apprentices, divided between the engine department, the deck department and the steward department. A third ship, the former Army transport "Meade" will soon be ready.

SOME OF THOSE WHO ARE HELPING AMERICA TO MAN HER SHIPS

Front Row (left to right)—Capt. Eugene E. O'Donnell, Supervising Inspector, Fifth District, U. S. Steamboat-Inspection Service; Capt. Robert M. Lavender, National Trustee, American Association of Masters, Mates and Pilots; Henry Howard, Director of Recruiting, United States Shipping Board; William S. Brown, National President, Marine Engineers' Beneficial Association; Capt. Arthur N. McGray, Secretary-Treasurer, Neptune Association, also representing the Masters, Mates and Pilots of the Pacific Coast.

Middle Row—Capt. Ulster Davis, National Trustee, American Association of Masters, Mates and Pilots; Capt. Luther B. Dow, Business Manager, American Steamship Licensed Officers Association, Inc.; George W. Willey, Business Manager, Marine Engineers' Beneficial Association, No. 59, of Boston; James J. Raftery, Jr., President, Marine Engineers' Beneficial Association, No. 59, of Boston; Capt. Irving Sparks, Boston Agent, Neptune Association.

Back Row—Winfield M. Thompson, Field Agent, U. S. Shipping Board Recruiting Service; Edward Clarence Hovey, Jr., Chief, Sea Service Bureau; Bert L. Todd, Secretary, Ocean Association of Marine Engineers; Thomas A. King, Chairman Board of Directors, Ocean Association of Marine Engineers; Henry G. Vaughan, Sea Service Bureau; Edward F. Flynn, Assistant to Director of Recruiting, U. S. Shipping Board.

Apprentices accepted for training are taken only after careful physical examinations. They sign an agreement to serve in the merchant marine for the duration of the war. It is expected that most of them will win promotion and remain in the service many years after peace is restored, for the United States is to maintain its rightful place among foremost maritime nations. Opportunities for advancement will be many.

Here is the program established for the men in training: 6 a.m., all hands tidy room; 7 a.m., breakfast; 8 a.m., general work; 9:30 a.m., discipline and instruction; 10 a.m., inspection; 10:30 a.m., boat drill; 11:45 a.m., clean up; 12 noon, dinner; 1 p.m., fire drill; 2 p.m., seamanship; 3 p.m., boat drill; 4 p.m., general work; 4:45 p.m., clean up; 5 p.m., supper; 6 p.m., muster and liberty; 6-9 p.m., recreation, bathing, etc.; 9 p.m., all lights out. There is one instructor for every ten apprentices.

The plan of training inexperienced young men on training ships evidently hit a popular chord from the first. In 48 hours after the announcement was publicly made that the "Calvin Austin" had been chartered as a training ship, more than 500 applications for enrollment on her were received at the national headquarters of the United States Shipping Board Recruiting Service at the Boston Custom House. Only American citizens are accepted for the training ships. All the instructors are American seaman to man American ships. The apprentices are paid $30 a month while training. The course is five to seven weeks.

Since the summer of 1917 the United States Shipping Board Recruiting Service has successfully trained engineer officers for the new merchant marine, finding its material among men already experienced as assistant engineers, firemen, oilers and watertenders. This work has been carried on at schools conducted by the Shipping Board at eight leading technical institutions in differ-

ent parts of the country, with Prof. Edward F. Miller, of the Department of Mechanical Engineering at Massachusetts Institute of Technology, as chief instructor in engineering. The schools will continue until a sufficient number of officers are trained for the new Government-owned cargo ships.

The free Government Schools conducted by the Shipping Board are located at the Johns Hopkins University, Baltimore; Massachusetts Institute of Technology, Cambridge; Armour Institute of Technology, Chicago; Case School of Applied Science, Cleveland; Stevens Institute of Technology, Hoboken; the Tulane University, New Orleans; The Bourse, Philadelphia; and the University of Washington, Seattle.

The course ordinarily lasts about four weeks. Instruction is free to those who qualify for admission, but students have to pay their own living expenses. On graduating from an engineering school, a student goes to sea for two months' special training as a junior officer at $75 a month, if necessary. He is then free to go into the merchant-marine service at prevailing rates of wages.

The Shipping Board Recruiting Service conducts a Sea Service Bureau, with headquarters at the Boston Custom House and branches at other ports, for placing its graduates. This service is free.

Ever since the Recruiting Service was established, it has conducted free Government navigation schools for the training of experienced seamen as deck officers. Forty-one of these schools have been established, from the Atlantic to the Pacific, wherever the demand seemed to justify them. The enrollment headquarters for all the United States Shipping Board Recruiting Service activities are at the Custom House, Boston.

These may qualify for training as chief engineer, ocean-going, in a Shipping Board engineering school: First assistant, one year, ocean or coastwise steam vessels; second assistant, two years, ocean or coastwise steam vessels; fireman, oiler or watertender of three years' engine-room service, ocean or coastwise steam vessels, may qualify as chief on ocean steamer of 500 tons or under; chief, one year, lake, bay or sound; first assistant, two years, lake, bay or sound.

These may qualify as first assistant engineer, ocean-going: Second assistant, one year, ocean or coastwise steam vessels; fireman, oiler or watertender of three years' engine room service, ocean or coastwise steam vessels, may qualify as first assistant, 1000 tons or under; first assistant, one year, lake, bay or sound; second assistant, two years, lake, bay or sound; apprentice to machinist trade, with three years' service on marine, stationary or locomotive engines and one year at sea; graduate in engineering, nautical schoolship, with six months at sea; graduate in mechanical engineering at a technical college, with six months at sea; locomotive engineer, two years, with one year at sea; stationary engineer, two years, with one year at sea.

These may qualify as second assistant engineer, ocean-going: Third assistant, one year, ocean or coastwise steam vessels; chief, six months, lake, bay or sound; first assistant, six months, lake, bay or sound; second assistant, six months, lake, bay or sound; third assistant, one year, lake, bay or sound; stationary engineer in full charge of a 1000 hp. plant; locomotive engineer, one year, and six months at sea; stationary engineer of plant of less than 1000 hp. who has had six months at sea; apprentice to the machinist trade who has had six months at sea; graduate in mechanical engineering at a technical college, with three months at sea;[1] graduate in engineering, nautical schoolship, with three months at sea.[1]

These may qualify as third assistant engineer, ocean-going: Fireman, three years; oiler or watertender, two years (or combined service of two years in these grades), ocean or coastwise steam vessels; chief, six months, lake, bay or sound; assistant, six months, lake, bay or sound; graduate in engineering, nautical schoolship; chief, one year, river; assistant, one year, river; journeyman machinist who has been engaged in construction or repairs of marine engines.

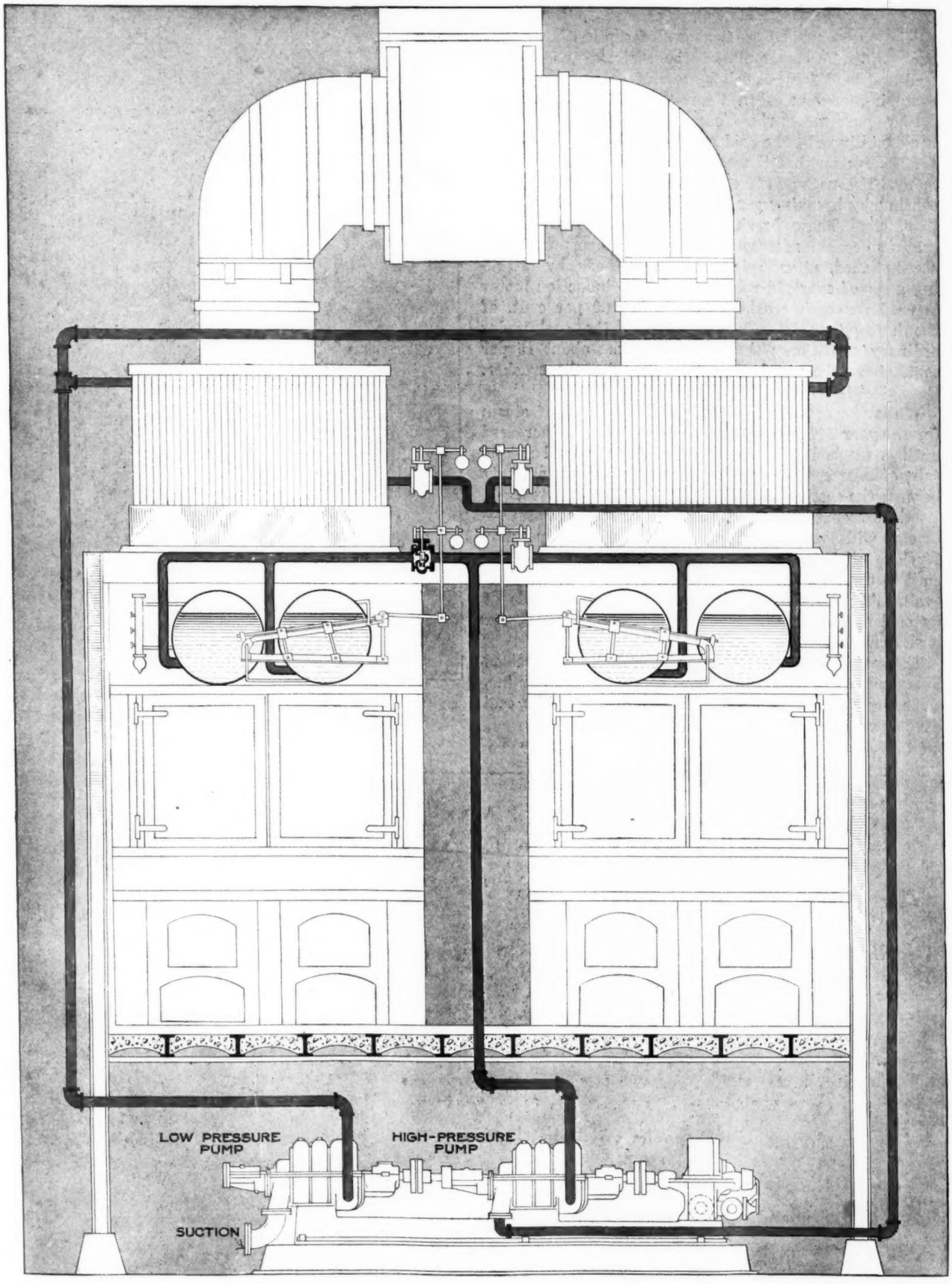
Increasing the Life of Economizers

Throughout New England particularly, the average life of an economizer may be estimated as about 18 years. During this time, because of internal and external corrosion, there is a gradual thinning down of the walls of the headers and tubes. How serious this becomes depends upon the local conditions in each case, but on the average it may be assumed that the walls of the tubes become so thin that they are liable to fracture after the economizer is about 13 or 14 years old. This liability to fracture is greatly increased by any sudden shock, such as a water-hammer.

After a period of 16 or 17 years the walls of the tubes become so thin that it is impracticable to carry the usual high boiler pressure. To overcome this difficulty C. W. E. Clark, of Boston, and J. V. Santry, of Schumaker-Santry Co., Boston, have patented the application of a three-stage centrifugal pump in connection with these older economizer installations. The water is pumped from the primary heater through one stage of the pump to the economizer at about 40 to 50 lb. pressure, then from the outlet of the economizer to the suction of the second stage of the pump, the pressure being increased to the required boiler pressure. So far as the writer knows, George Diman, of Lawrence, Mass., was the first to propose this method of feeding water to economizers.

The application of this type of pump has materially increased the life of several economizer installations. In one case where the repairs had become excessive a pump of this type was installed and the pressure cut down from 175 lb. to 40 lb. This prolonged the life of the machine for a period of four years, and practically all the repairs due to tube and header fractures were eliminated during this period. The accompanying illustration shows all this so plainly that further description is unnecessary. During these times of high fuel costs and fuel shortage this method of feeding the water should effect worth-while savings in any plant where the economizer is out of service because it will not stand boiler pressure, but would hold if the pressure were reduced. The advantage of feeding, as shown in the full-page illustration, is that no boiler will "rob" the other of water; each will take what it needs without interfering with the other's supply.

[1]This three months' service at sea may be obtained after graduation from the school and before taking United States Steamboat-Inspection Service examinations, for license as an officer.



FEEDING WATER AT LESS THAN BOILER PRESSURE TO OLD ECONOMIZERS AND REGULATING FLOW AS REQUIRED TO EACH BOILER AND ECONOMIZER

Foreign Substances in Coal

The photograph, Fig. 1, shows of a pile of slate and rock which is a sample of the material received as coal and paid for as such by one of the largest manufacturing companies in Connecticut. The pieces are so large as to convince one that they were not left accidentally with the coal as it came out of the mines, for the reason that it was not in one or two cars, but many. It causes no end of trouble with the coal crusher, continually breaking gears and pinions, smashing bearings, etc. These breakdowns occurred so frequently that it became necessary to prevent them; this was accomplished, after trying various methods, by installing a set of overload relays. A 20-hp. induction motor is used for each crusher; only about 60 per cent. of the horsepower is required to crush the coal under ordinary conditions; the relays were set about 15 per cent. above the usual required power for the crusher. Cast steel is now used for the crusher gears.

While the average monthly cost per pound of steam for the year 1916 was $0.00027, it has greatly increased until it reached a figure of $0.00042. It would not be fair, of course, to charge this increase to bad coal only because the cost of labor and material has increased.

Sticks, stones, chains—most anything of that nature—in coal will cause serious delays, damage and possible service interruptions in a power plant. Protest by mail to the mine owners, when bought direct, is of no avail. As New England ordinarily gets two-thirds of its coal by water, Fig. 2 is of particular interest, for it shows what comes in with the coal in barges.

The company from which the photograph was received now sends such pictures, without comment, to the mine, and since doing this the foreign substances in the coal have greatly decreased. Try it.

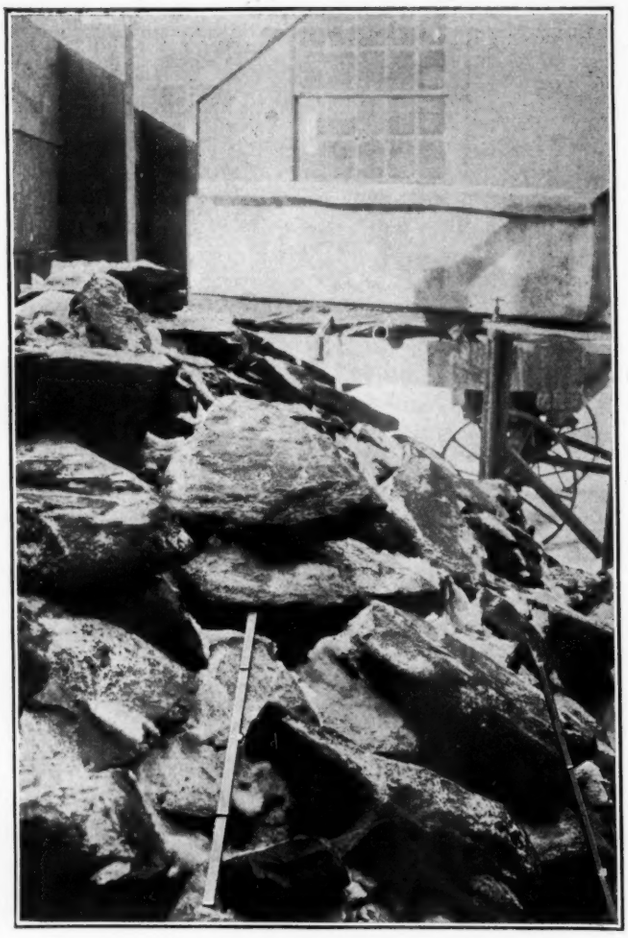


FIG. 1. SLATE AND STONE TAKEN FROM COAL SOLD IN NEW ENGLAND. NOTE THE TWO-FOOT RULE

FIG. 2. SOME THINGS THAT COME IN COAL AND DAMAGE THE CRUSHER AND STOKERS

Bonus For Power-Plant Employees

By WARREN B. LEWIS
Consulting Engineer, Providence, R. I.

Bonus paid to power-plant employees does not mean that they must originate saving on which the bonus is based. The author bases the bonus on the saving in power-plant costs per unit output of product manufactured and gives detailed directions for enabling the management to quickly determine by reference to a curve, the bonus due employees.

THE term "bonus" generally means something over and above a fixed compensation or price, based on the net saving effected. It means that if the operator can reduce the cost per unit of product, he should receive a proportion of the savings. It does not mean that he is to originate the methods to be employed. A course of instruction may be, and generally is, necessary, but methods having been established, the employee receives a proportion of the savings effected because he maintains the standard set.

Establishing a Base-Line

In establishing a bonus there must be a starting point, which should be a reasonable efficiency. Call this a base-line. If the plant as a whole has been well operated, then its cost for a period of two or three years might be taken as the base-line. If there have been glaring faults, these should be corrected before the base-line operating costs are established.

The start must be made with the sum total of power-plant expenses, which must bear some definite relation to the product turned out in the plant as a whole. There are few cases where the cost of power (and I refer now to all the items under the general heading of power) does not bear a definite relation to the product manufactured. If the plant is operated at 100 per cent. capacity, the power-plant cost should bear a definite relation to the product in terms of pounds, bushels, yards, tons, etc. If the plant is operating at 50 or 20 or 80 per cent. of its capacity, the cost of power for each will have a relation unlike the others.

It is possible, then, to establish a curve that will show what the power-plant costs per unit of product should be at any given output, and this is the measure most satisfactory, as it includes every factor that enters into power costs. The manager need not worry about boiler or engine efficiencies, uses of steam or economical heating and lighting of buildings, but can group these under the general heading of "Cost per Unit of Product Manufactured," and the weekly or monthly report showing the power-plant costs need be simply divided by the product of the plant to determine whether the set standard is being maintained. He can then compare this cost with those of other plants with which he is familiar or to whose costs he has access.

The first step in establishing a base-line is to divide the power-plant costs into two items—those which bear little or no relation to the volume of product and those more or less proportioned to the volume of product. In every industry there are cost items that are fixed. Some of these are familiar to the accounting department and some are not. The familiar ones are interest, depreciation, taxes, insurance, etc., which are termed "overhead"; but there are others which are as definitely fixed. If the power plant is ready to serve the factory with any amount of power up to its maximum, then the other fixed charges consist of cost of labor, fuel required to bank fires and to keep engines, generators, pumps, etc., turning over but developing no useful power, certain amounts for lubricants, water, ash removal, etc. To a great extent the heating of buildings is an overhead charge against the power plant and is not affected materially whether the plant is running at 25 per cent. or 100 per cent. capacity. In some cases heating may have to be divided into the two elements, but in most cases it is a fixed charge. A certain amount of lighting comes under the head of fixed charges and is not affected by the volume of output.

We have, therefore, to determine, first, what the real fixed charges are on any individual power plant, and one proceeds as follows: Make an appraisal of the plant, determine the value of the land and buildings occupied, of the complete boiler equipment, engines, pumps, heaters, piping, generators, switchboards—everything concerned in the production of power, steam, light and heat, not forgetting the sprinkler systems, lighting systems, etc., which apply wholly to the power plant; also the main lines of pipe running to production centers in the manufacturing buildings, as well as main lines of wires, etc., these being a part of the power plant. Generally, the branch lines and pipes in manufacturing departments are considered as a part of the department and are not concerned in the establishment of power-plant costs. This appraisal having been made, certain charges are entered such as are commonly called overhead; namely, interest, depreciation, taxes, insurance, etc.

Determining Stand-by Losses

The second step is to determine what may be called "fixed costs regardless of output," or *stand-by losses,* in some such manner as follows: If the boilers are maintained at the usual pressure, engines turning over at normal speed, generators excited but delivering no current to the lines, or, in case of mechanical drives, shafting turning but all productive machinery stopped, a certain quantity of coal is being used which may be considered as a fixed cost regardless of production. This includes coal used in banking fires and rebuilding fires which have been cleaned. If one wants to be very accurate, the amount of ash resulting from the burning of this fixed amount of coal is determined, and the cost of removing that ash added.

Next determine what lubricants are used irrespective of production, and certain supplies such as pump and engine packings, boiler gaskets and numerous other things that are not affected by production. Current used for lighting main passageways, the yard, the engine and boiler rooms, etc., is a fixed charge. Coal used on Sundays and hoildays and that used at night is also a fixed charge.

The heating of buildings may in most cases be considered as a fixed factor. In some plants a decrease in the output carries with it the possibility of decreasing the number of departments to be heated; but in most cases the heating will be a fixed item and will not vary generally with the percentage of production of the plant.

Practically all labor employed in the power plant is a fixed item.

A considerable proportion of the total costs is as truly a fixed charge as are the usual overhead items; and the natural result is that if the plant is operating at 50 per cent. capacity, the cost per unit of these fixed charges is twice what it is when the plant is operating at 100 per cent. capacity. It is this that makes the final cost per unit of product not proportional to the volume of product.

The third item to determine is the variable costs of the power plant, those which change with the product. As the amount of power required increases, the coal will increase in fairly direct proportion, assuming that the prime movers have a fairly flat water rate. If they do not, it is a simple matter to plot the relation between coal and product as a slight curve rather than as a straight line. If the boiler-feed water is purchased, it will be an item varying with the factory output. A certain part of the ash and a certain percentage of supplies will also be directly affected by the output. We have, therefore, a group of items which increases nearly proportionally to product, and in many instances may be considered as a straight line. If we now combine these two sets of costs, we get a line that shows the actual variation in cost as the productiveness of the plant varies.

To illustrate: Assume a power plant of the simplest character, of 1000 hp., where mechanical power is the only thing required and the equipment is concentrated. The plant is appraised at $100,000; and for the first item we have the overhead, which may be taken at 15 per cent., covering interest, depreciation, insurance and taxes, which is equivalent to $1250 a month. This overhead has no relation to the volume of output and in Fig. 1 is plotted as a straight line.

The next item is the stand-by losses, which are affected by the output. These consist of the following items in dollars per month: Labor, $606; coal, $1170; oil, $37; supplies, $25; repairs, $40; water, $10; total, $1888. The items of supplies and repairs represent the materials used to keep the machinery in good working order, whether it is developing one horsepower or a thousand. The item of $1888 is drawn as a horizontal line because in every respect it is practically the same as overhead. The sum of these two items is plotted as a horizontal line at $3138.

The third item is the expenses which are proportional to product, made up as follows, if the plant is delivering 1000 hp.: Coal, $3510; repairs, $40; water, $100; total, $3650. This is plotted as a diagonal line, with the figure $3650 against 100 per cent. output with proportional amounts against lower outputs; namely, $2737.50 at

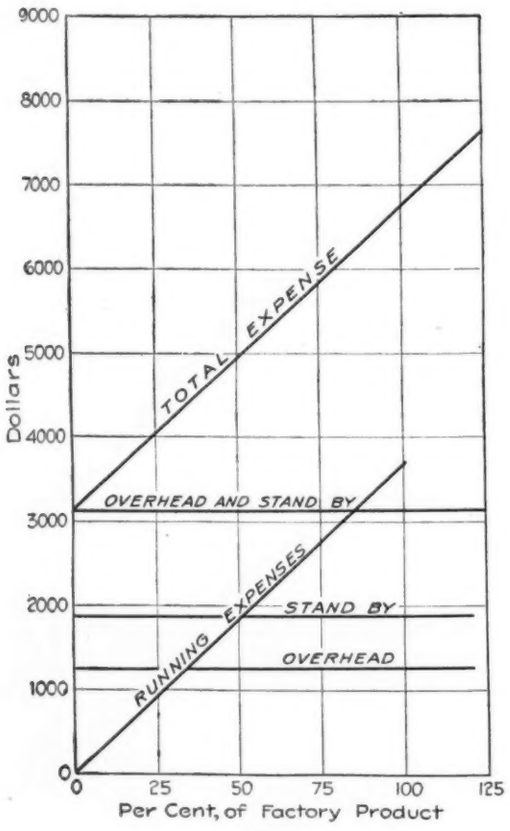


FIG. 1

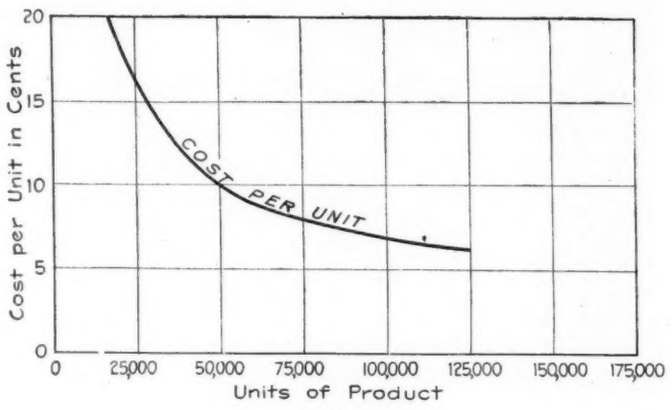


FIG. 2

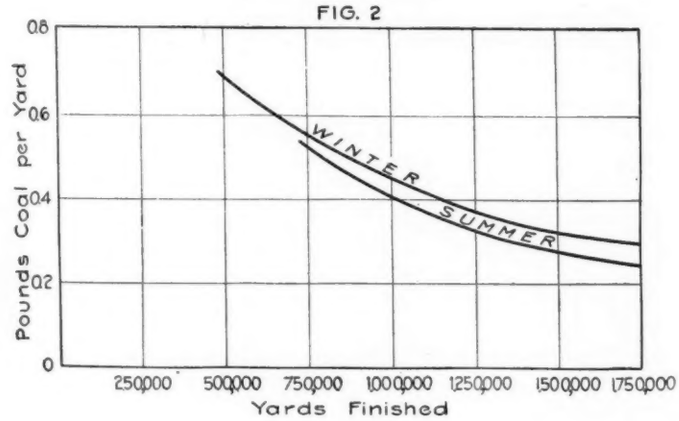


FIG. 3

FIGS. 1 TO 3. CURVES PLOTTED WHEN PLANNING A BONUS SYSTEM

Fig. 1—Expense Chart. Fig. 2—Unit Cost Curve. Fig. 3—Coal Consumption Per Unit of Production.

75 per cent. output, $1825 at 50 per cent. output, $912.50 at 25 per cent. output, and 00.00 at 0 output. If this diagonal line is now added to the item of overhead plus standby, the total costs are plotted as a diagonal line beginning at the figure $3138 for 0 output and ending with $6788 for 100 per cent. output. If the plant runs a month at 25 per cent. output, the cost would be $4050.50. If it runs a month at 75 per cent. output, the cost would be $5875.50. This chart shows at once the tremendous influence that the stand-by and the overhead have, and how necessary it is to keep them at a minimum. The importance of this is frequently overlooked. In this assumed case they are nearly 50 per cent. of the total maximum cost at 100 per cent. factory output and are more than 60 per cent. of the total cost at 50 per cent. factory output. If we divide the cost for any given week by the productiveness for that week, we establish the power-plant cost per unit of product output.

Fig. 2 illustrates the ratio between product and cost. Instead of using percentages, we may convert this into thousands of units, such as pounds, bushels, yards, etc. Taking the total operating cost at 100 per cent. output of $6788 and considering that 100 per cent. output means 100,000 units, then the cost per unit is 6.788c. At 75 per cent. output, or with 75,000 units, the cost would be 7.83c.; at 50 per cent. output, or 50,000 units, the cost would be 9.9c.; at 25 per cent. output, or 25,000 units, the cost would be 16.2c. per unit. If this chart is kept before the management, it is only necessary to pick out on the curve the proper cost for any given output to determine whether the standard has been maintained. In making such a chart the records of total cost of power should be divided by the output for each period and plotted regularly.

It may take many weeks to check up such a curve. If the factory is operating at about a certain definite percentage of capacity, the opportunity will not be presented to find the actual ratio at some other percentage until the rate of percentage goes up or comes down. In some cases it has taken nearly a year to check up a curve with actual performance; and even then the curve is bound to be a mean between certain extremes.

Stand-by-Losses Should Be Watched Carefully

In those industries where steam, hot water and other evidences of power are distributed about the plant, it will be found that the stand-by plus the overhead is a much larger proportion of the whole. In some cases it has been as high as 70 per cent. at 100 per cent. production and a correspondingly larger amount at lower rates of production. This makes it doubly important to watch the stand-by losses even more carefully than the variable running expense. If the industry is such that the influence of the out-of-doors temperature is considerable, then two curves should be established, one for summer and one for winter conditions, the transition from one to the other being more or less arbitrary and depending somewhat upon the climate.

Fig. 3 illustrates two curves that actually apply to an industry where large quantities of steam and water are used and the cost of heating water in winter is much greater than in summer. In this plant the bonus is figured on the coal consumption alone. The curve shows the ratio between production and pounds of coal per unit of production, and well illustrates the rising cost of coal per unit when the factory output is increased. It is evident that it is quite impossible to judge fairly from a week's operation. It is almost impossible in many industries to get the actual product for one week. Materials may be put into process which do not reach the packing room for several weeks, and more goods may be shipped than are in actual process in any given week. It is therefore necessary to figure costs over a longer period, say four weeks, or by calendar months; and at the same time determine with a fair degree of accuracy what is the actual output of finished product.

The curve, then, becomes the basis of a bonus system of payment. Some engineers have argued that it is not a fair one, that all that the operating engineer can do is to make steam efficiently, run his engines, pumps, heaters, etc., as well as he knows how, and that he has no control of the situation beyond his department. That is partly true and partly not true. The functions of the chief engineer should extend beyond the confines of the engine and boiler rooms. He should spend at least one-third of his time around the plant, and he should have an inspector going around the plant continually watching out for improper use of power, light, steam, etc. The chief engineer should be directly concerned in seeing that the process machinery is maintained in an efficient condition. This is particularly true with regard to apparatus that uses steam in any form. If we include in the power plant all the equipment which in any way affects the use of fuel, it becomes a comparatively simple matter to place upon the chief engineer the responsibility for the efficiency of the entire power-making and power-using equipment, and for its cost per unit of production.

Specific Application to Bleachery Plant

An instance of the specific application of the theory herein advanced is that of a cotton-cloth bleachery and finishing plant. Here the measure was the number of yards of cloth finished in a given period, and it was found that an average of the number of yards put into process and of the yards shipped could be taken as the basis of production. Distributed over a period of four weeks the inaccuracy due to the possible holding up of goods in the plant was shown to be more or less reduced. From records extending over a period of two or three years it was found that for any given production the amount of coal burned did not vary much notwithstanding a great variety of processes carried on and continually changing methods of handling goods. This was accounted for largely by the fact that the fixed operating costs, as before explained, were a large part of the whole. The ratio between the coal burned and the yards finished was not a constant one by any means, but varied with the volume of the product, so that a curve could be produced which would show the actual ratio under any given conditions. This curve was based on costs as they had been for a considerable period of time. The employees of the power plant were offered a certain percentage of any saving they could effect. The chief engineer did not accept the offer with any interest, explaining that he did not believe that a material saving could be made. The company employed a consulting engineer to study the conditions in the power plant, with the result that with the coöperation of a new engineer the costs were greatly reduced and the em-

ployees received substantial rewards. The saving came not only through the better operation of the machinery, but through the reduction in the use of steam all over the plant.

Two factors must be recognized, one of which has been already mentioned—that of proper advisory service and a process of education. By far the most important is the attitude of the management toward the whole plan. There must, first of all, be a keen desire to reward the power-plant force for their efforts and a genuine feeling that a man's earnings should be based on what he saves his employer rather than on what some other man gets. Because $30 a week is a recognized standard for a certain class of help is no reason why a man should not get $10 a week additional if his employer can make $10 or $20 or $30 a week additional out of the man's effort. The bonus paid the first year will come from the actual reduction in costs of operation. The bonus paid after that will be due, not so much to still further reducing costs, as to keeping them down to a minimum; and it is certainly worth as much to keep the costs down as to bring them down in the first place.

Work of the Massachusetts Boiler Inspection Department

In the accompanying Tables II and III, are given the chief items of interest in the work of the Boiler Inspection Department of the State of Massachusetts since preliminary investigations by Thomas Hawley, of Boston, in 1893 and 1894 up to 1917. The tables should be of considerable interest to all those interested in boiler legislation, construction and operation.

The total number of Massachusetts standard boilers and air tanks constructed, received into the state and reported during the last five years, are given in Table I.

The following insurance companies are authorized to insure and inspect boilers in the Commonwealth: Employers Liability Assurance Corp.; Fidelity and Casualty Co.; Hartford Steam Boiler Inspection and Insurance Co.; Maryland Casualty Co., Mutual Boiler Insurance Co., Royal Indemnity Co.; and Travelers Indemnity Co. The 148 insurance inspectors, certified by the state, inspected 19,607 boilers and 376 air tanks in 1917.

It is interesting to note some of the violations of the various laws enforced by the boiler inspection department during the last year: assaulting an officer, 1; causing a boiler to be operated by person not properly licensed, 2; causing boiler to be operated without necessary safety appliances, 1; operating boiler without certificate of inspection, 4; failure to pay boiler inspection fee, 3; operating steam plant without proper license, 5; operating electric derrick without license, 1. It is seen that violations are few.

When the German steamship, the "Kronprinzessin Cecile" was interned in Boston, members of the department took charge of the mechanical equipment aboard. Since the outbreak of the war three members have entered service under the flag.

TABLE I. BOILERS AND AIR TANKS INSTALLED DURING LAST FIVE YEARS

Year Ending Oct. 31	Mass. Std. Boilers	Mass. Std. Air Tanks	Total
1908 (from May 1)	519	...	519
1909	1,365	...	1,365
1910	1,642	...	1,642
1911	1,604	...	1,604
1912	2,002	...	2,002
1913	2,860	...	2,860
1914	2,738	...	2,738
1915	2,291	214	2,505
1916	1,665	178	1,843
1917	1,788	216	2,004
Totals	18,474	608	19,082

TABLE II. EXAMINATIONS AND FEES PAID TO STATE TREASURER

Year Ending Oct. 31	—Inspections— Boiler Inspec. Dept.	Insurance Companies	Total	—Examinations— Engineers and Firemen	Operators of Hoisting Machinery	Total	Fees Paid to State Treasurer
1893	171*	....	171	.....	.....	.....	.....
1894	405*	....	405	.....	.....	.....	.....
1895	306	....	306	1,605	.....	1,605	$15,263
1896	719	....	719	11,703	.....	11,703	6,628
1897	1,528	....	1,528	9,274	.....	9,274	8,699
1898	1,961	....	1,961	5,655	.....	5,655	9,590
1899	2,626	....	2,626	5,981	.....	5,981	13,142
1900	2,364	....	2,364	6,472	.....	6,472	11,438
1901	2,814	....	2,814	6,389	.....	6,389	13,203
1902	2,583	....	2,583	6,518	.....	6,518	11,447
1903	2,448	....	2,448	5,873	.....	5,873	10,977
1904	2,441	....	2,441	5,850	.....	5,850	10,628.53
1905	2,555	4,080	6,635	5,725	.....	5,725	12,832.00
1906	2,363	12,000	14,363	6,612	.....	6,612	15,382.50
1907	3,043	12,467	15,510	7,140	.....	7,140	18,801.00
1908	3,698	13,739	17,437	7,129	.....	7,129	22,066.00
1909	3,763	16,032	19,795	6,657	.....	6,657	23,735.00
1910	3,837	15,972	19,809	6,867	.....	6,867	23,356.00
1911	4,510	15,986	20,496	6,948	161	7,109	25,036.00
1912	4,334	16,766	21,100	6,737	291	7,028	22,604.00
1913	5,403	17,006	22,409	6,404	134	6,539	25,558.00
1914	6,746	18,010	24,756	6,490	147	6,637	27,457.20
1915	6,987	19,456	26,443	5,364	141	5,505	27,698.00
1916	7,360	19,254	26,614	5,174	116	5,290	27,766.00
1917	6,892	19,983	26,875	5,022	93	5,115	26,635.00
Totals	81,857	200,751	282,608	147,590	1,083	148,673	$409,942.23

* Preliminary investigations.

Original Boiler Inspection Law (Chap. 418, Acts of 1895) May 29, 1895.

Original Engineers and Fireman's License Law (Chap. 471, Acts of 1895), June 5, 1895.

Original Operation of Hoisting Machinery Law (Chap. 656, Acts of 1911), July 11, 1911.

Original Air Tank Inspection Law (Chap. 629, Acts of 1913), May 8, 1913.

Original Ammonia Compressor Safety Valve Law (Chap. 467, Acts of 1914), May 2, 1914.

TABLE III. BOILER EXPLOSIONS INVESTIGATED BY THE BOILER INSPECTION DEPARTMENT OF THE MASSACHUSETTS DISTRICT POLICE

Year	Explosions	Kinds of Boilers	Locations	—Number of Persons— Killed	Injured	Causes of Explosion
1895	1	48-in. horizontal-tubular	Webster	0	0	Ignorance of fireman
	1	60-in. horizontal-tubular	Woburn	5	Large number	Stuck safety valve
	1	48-in. horizontal-tubular	Fall River	4	Several	Lap crack
	1	48-in. horizontal-tubular	New Bedford	1	0	Overpressure
1896	0	.....	.....	0	0	.....
1897	1	72-in. horizontal-tubular	New Bedford	2	0	Lap crack
	1	72-in. horizontal-tubular	New Bedford	...	.....	Explosion of other boiler
1898	1	.....	Hubbardston (icehouse)	3	1	Defective flue
1899	0	.....	.....	...	.....	.....
1900	0	.....	.....	...	.....	.....
1901	0	.....	.....	...	.....	.....
1902	0	.....	.....	...	.....	.....
1903	0	.....	.....	...	.....	.....
1904	0	.....	.....	...	.....	.....
1905	1	72-in. horizontal-tubular	Brockton (Monday morning, Mar. 20)	58	117	Fracture of shell plate at longitudinal joint
1906	1	72-in. horizontal-tubular	Lynn	0	17	
1907	1	60-in. horizontal-tubular	Hubbardston	1	0	
	1	Cast-iron sectional	.....	0	0	Defective casting
1908	0	.....	.....	...	.....	.....
1909	0	.....	.....	...	.....	.....
1910	1	42-in. horizontal-tubular	New Bedford	0	4	Fractured shell plate at longitudinal joint
	1	35-in. locomotive-type	Pittsfield	17	0	Over pressure
1911	0	.....	.....	...	.....	.....
1912	0	.....	.....	...	.....	.....
1913	0	.....	.....	...	.....	.....
1914	0	.....	.....	...	.....	.....
1915	1	60-in. horizontal-tubular	East Weymouth	1	8	Fracture of shell plate at longitudinal joint
	1	Cast-iron sectional	Beverly	0	0	Explosive in combustion chamber

The Forcible Shutting Down of Isolated Power Plants

By PERCIVAL R. MOSES

A complete account of the various events which led up to the hearings now being held before the Public Service Commission for the First District of New York, to determine the advisability of shutting down isolated plants and substituting central-station service, in order to save coal.

THE Public Service Commission is holding a series of hearings which are technically directed to the question of the rates for breakdown and auxiliary electric service and which are largely an investigation of the possibility of establishing an off-peak rate for electricity which shall induce owners and operators of private power plants to shut down such plants when the use of fuel in them is greater than it would be if the electricity were derived from the New York Edison Co. or some other public utility.

The history of the case is as follows: In November of last year, when the threat of fuel scarcity became imminent, I wrote the Fuel Administration in Washington, suggesting that a great measure of fuel conservation would be obtained if coöperation between public utilities and the owners of private or isolated power plants could be enforced. This letter, which clearly outlines my position, is as follows:

366 5th Ave., New York City, Nov. 9, 1917.

United States Fuel Administration,
Washington, D. C.

Dear Sirs: I have written you before, suggesting that a very large amount of fuel could be saved by enforcing coöperation between the public utilities and the owners of private, or isolated, power plants. I have not heard from you further in the matter, and I assume that the immense amount of work you have had to do prevented a careful consideration of the matter, because there can be no possible dispute as to the facts. What I want to see accomplished is the supply by the public utility of all electricity which it can most efficiently supply, and the supply by the private power plant of all the electricity it can most efficiently supply.

That there are distinct fields for each type of plant is evident on the slightest consideration of the subject. A large building needs coal to heat it. The heating is accomplished by steam at low pressure. By adding 3 or 4 per cent. to the amount of heat in the steam, the steam can first be made to drive engines and dynamos making electricity and afterward be used for the heating. In this way all the energy delivered by the coal to the steam is utilized, whereas in the public-utility plant of the best type not over 15 per cent. is utilized. On the other hand, during certain periods of the year and certain periods of the day and night the more efficient plants of the public-utility company should be utilized and the engines of the private plant should be shut down, as such engines are, of course, inefficient except when their exhaust steam can be utilized.

I have estimated that 100,000 tons of coal a year could be saved in New York City alone by carrying out this coöperation to a reasonable extent. A practical example will show that this idea is not a theoretical one. The Columbia Trust Co. owns a building at 60 Broadway, about 20 stories high, 60 x 150-ft. plot. Electricity was purchased one year in the winter and the next year it was generated in the building. The same kind of coal was used under the same conditions of firing. Less coal was used during the months of December, January, February and March in the year when the electricity was being generated than was used in the same period when electricity was being purchased. Approximately 150,000 kw.-hr. of electricity was generated during the period, and this would have required of the Edison company, allowing for wastes and distribution, over 200 tons of coal, so that by this change in one building a saving to the community of 200 tons of coal was effected.

This same condition has been shown to exist in a number of other instances where a number of tests have been made with and without electric generating plants. For example, we made a test for the Mutual Insurance Co., Richmond, Va.—24 hours with their own plant and 24 hours with purchased electricity, running their own steam plant, during the winter season—and the results were the same as I have mentioned at the Columbia Trust Co.; that is, less coal was used when the plant was running than when the plant was not running. On the other hand, it is a well-known fact that the engines used in private plants are far less efficient than the turbines of the big central stations, so that in the summer months the use of coal by the private power plant for a given quantity of electric current must be more than in the central station, so that from the point of view of the community it would pay during the summer months to have the electricity generated at the central-station plant. This coöperation could be easily obtained by a system of rates for electric current which would make it economical for a private-plant owner to use electric current during the summer and other light-load periods. The advantage to the public utility must be obvious, as an additional load would be obtained which would involve practically no additional investment.

This letter received a prompt reply from the United States Fuel Administration, referring it to O. P. Hood, chief mechanical engineer of the Department of the Interior, who was working for the Fuel Administration. Mr. Hood requested a more detailed statement of my suggestion, which I sent him within a few days. This was acknowledged on Dec. 6, stating that the matter had been referred to another and that the desirability of coöperation was not questioned, but that the difficulty appeared to be that of getting a definite knowledge of conditions.

In another letter of Dec. 26, Mr. Hood said that it seemed to be better to bring the matter to the attention of the local fuel administrators, and this was done by me in a letter of Jan. 2, to Mr. Wiggin and Mr. Schley, state and county administrators, to whom I submitted a brief plan, as follows:

Outline of Plan of Coöperation

Hundreds of thousands of tons of fuel could be saved if through coöperation between the public-utility plant and the private power plant each of these could be operated to its utmost efficiency. While this cannot be entirely realized, there is a very simple plan by which it can be realized in large measure.

First, private plants should be shut down during the summer months and during the balance of the year with the exception of the very cold winter weather during the so-called "off-peak" period, which in the vicinity of New York is from 10 p.m. to 6 a.m. That is, I would advocate the shutting down of private plants except those which are utilizing their exhaust steam for manufacturing purposes during the nonheating season—May, June, July, August, September and October—and during the other months, with the exception of December, January, February and March, from 10 p.m. to 6 a.m., with the possible exception

of hotel plants, as in these plants exhaust steam is largely used for heating water and for drying purposes; hence, high efficiency is obtained.

These plants may be shut down without hardship to the owners provided a rate is made by the public-utility company which would not exceed 2c. per kw.-hr. for moderate consumers—that is, consumers up to 1,000,000 kw.-hr. per year—and possibly 1½c. per kw.-hr. to consumers of larger quantities.

The public-utility company can easily afford to make such a rate because the current it would supply during these periods would be off-peak current, which could be furnished without any increase in investment in plant or in underground mains or in real estate; hence, the only increases to which the public utility would be subject would be increases in operating expenses and the small cost of connections from the underground mains to the buildings. In most cases it will be found that connections are already in, so that in reality the only increase to the public utility would be the increase in operating expense. This will be found to be less than one cent per kilowatt-hour.

Second, private power plants should be encouraged to develop their market for steam and electricity in their immediate neighborhood during the heating season up to the extent of their present capacity, as in this way the most perfect utilization of fuel and labor can be obtained.

Reasons for the Suggested Changes

The reason why these changes should be made is that in the winter months when the private power plant is operating, supplying electricity and steam for heating, almost perfect utilization of the heat contained in the steam is obtained, as the steam is first used at high pressure to generate power and electricity, and then afterward as exhaust steam is used for heating purposes. During this same period the public utility is generating steam at high pressure and is wasting a large part of the latent heat in the exhaust steam because it has no place to use it.

On the other hand, during the summer months in such plants as cannot use their exhaust steam for drying or manufacturing purposes or for heating water, the private plant wastes 95 per cent. of the heat contained in the steam, whereas the central plant on account of its high efficiency equipment and condensers wastes only 85 per cent.

In so far as the off-peak load is concerned, the public utility would benefit because it would obtain a load which would bring its average load up to a more efficient point; that is, the private-plant load would help fill in the valleys of the public-utility load, or as it is usually expressed, the load factor would be bettered.

Shutting down private plants during the off-peak period would shut them down when they are least efficient, in the use of both fuel and labor. I have known cases where the coal per kilowatt-hour ran to 30 lb. during these light-load periods, and 20 lb. is quite common. It results, therefore, that if a plan such as that just outlined should be adopted, instead of obtaining from 200 to 250 kw.-hr. per ton of coal burned, there would be obtained from 700 to 800 kilowatt-hours.

The danger of making suggestions to bankers and others with but little knowledge of engineering matters was demonstrated strikingly by the circular sent out by Albert H. Wiggin, state fuel administrator, on Jan. 14, 1918, urging owners of private power plants having breakdown-service connections to utilize to the fullest extent their connection with the Edison company, and on Jan. 15 I wrote to Mr. Wiggin pointing out the error of his suggestion and that instead of fuel being conserved by obtaining electricity from a central source in winter months fuel would be wasted.

Many of these letters were sent to the Public Service Commission of the First District with the request that they start a series of hearings looking to the establishment of an off-peak and summer rate for current and urging the necessity of quick action so that an equitable rate might be made and the new methods go into effect at the close of the heating season.

These hearings started on Feb. 25, and so far the commission has simply asked the public-utility officials to state their side of the case, which they have done at great length with practically no cross-examination.

Mr. Wiggin's letter and other indications apprised me of the fact that influence was apparently being brought to bear to take advantage of the country's necessity in an attempt to shut down private power plants generally, winter and summer, regardless of the fact that during the winter months and during such other periods of the year when exhaust steam can be fully utilized the private power plant is the most efficient means of production.

A circular letter was therefore addressed by me to a great number of owners of private power plants, calling attention to this condition, and a number have agreed to join with me in properly presenting the facts as we see them and as I have outlined them already to the Fuel Administration.

Benefits To Be Derived by Use of Plan

My position in the matter is that if the plan as outlined is carried out, the public utility will benefit by obtaining a large additional amount of profitable business at a minimum of cost. The country will benefit because the minimum amount of coal will be used for the generation of electricity. The private-plant owner will benefit because he will obtain the electricity used by him during summer and off-peak periods at not more than his present cost and he will be relieved of the necessity of operating the private plant.

I estimate that the saving in fuel in New York City alone if the plan outlined was carried out in full would be in excess of 200,000 tons per year, and if the plan was extended throughout the country the conservation of fuel would mount up certainly over a million tons per year. In addition to this a certain amount of labor would be released for other service, and this under the present conditions is equally important.

The facts as I have presented them seem to be indisputable. The plan presented is practical, and it is merely an attempt to apply a correct economic solution to the problem of the supply of light, heat and power. It is presented neither on behalf of the owner of the private power plant nor on behalf of the public-utility company, and for the reason that it is not an ex parte proposal it should be considered on its merits

Editorials

Investing in Liberty

JUST what is this thing called liberty in which and for which we are asked to invest billions? For the individual liberty is simply the ability to react to impulse, to the impulse of hunger or thirst, of self-defense or self-preservation, as well as to those higher impulses of self-determination with which we usually associate the word. With a complete lack of liberty life would cease. It is as necessary to life as air and light and water and food—in fact, more necessary, since in the last analysis it means access to these things. And up to a certain point, as in the case of all these things, the less liberty the less vitality. One may exist on a little liberty, as on a little air or a little food, but one cannot support normal life on it unless it is abundant.

But there is such a thing, also, as too much liberty, as of all the other necessities of life. And furthermore, it is not a thing whose supply is inexhaustible. Like air or light or water, it can be so restricted by monopoly that untold suffering and death result to those whose access to it is cut off. Look at Belgium or Germany itself.

The Prussian Junker would hardly consider as liberty the restrictions which we in this country impose upon our conduct. He would miss here that superabundant liberty to which he has become accustomed in the land of the Kaiser—to saber civilians who make faces at him, to elbow women off the sidewalk, to radiate arrogance with impunity. He would scoff at our sensitiveness to the rights and feelings of our neighbors, at our habit of chivalry and of kindness and compassion toward those weaker or more helpless than ourselves. This thing which we call liberty in America, this everyday conduct hedged about by law and conscience and the dictates of humanity, to the German Junker seems a mockery of the word. But by liberty he means a monopoly of liberty, and we, its proper distribution.

It is to secure and preserve for every inhabitant of the United States his share of liberty, that greatest of life's necessities, that we have declared war against the Hun Monopolist, that we are sending hundreds of thousands of our boys to the firing line in France, that we have bought billions in Liberty Bonds, and are now to begin the third loan campaign on April 6, to multiply that great investment. It is worth every cent of the mighty effort and much more. Would you fight for a water hole after a day's ride across the desert? And if you could not fight, would you give your all for access to that elixir of life without which you must go mad or die? Then fight for liberty; it is equally precious. And if you can't fight, give—give your all, or, rather, in this case, lend it at a good rate of interest. For, happily, your forefathers have so fortified your position in this world that you are bound to receive your contribution back with interest.

It is impossible to pay too much for, to invest too much in, liberty. The need is great that every man, woman and child in this country put everything he is and has into this vital struggle, once for all to smash the would-be monopolist and all his breed. We have floated two mighty loans already, now comes the third. As our artist has depicted in the colored supplement to this issue, the Kaiser is tottering on his pedestal. Therefore, again with Uncle Sam, *one, two, THREE, NOW, ALL TOGETHER!*

Inefficiency in Refrigerating Plants

IN last week's issue of *Power* an interesting paper on the economy of refrigerating plants was presented Apparently, conditions in this field are far from ideal, as the author ventures the opinion that "of all power plants the refrigerating plant is most wasteful." By and large this statement is probably true, and as to the reasons, there are several having an important bearing. Although the refrigerating cycle is not particularly difficult to understand, as it is practically the reverse of the condensing steam plant, there are many factors entering into the ultimate economy. This multiplicity of factors, each a source of possible waste, and the proper correlation of the various elements of the refrigerating and steam plants, make economical results more difficult to obtain. Further reasons are a decided scarcity of good refrigerating engineers and general inability on the part of the management to realize the possibilities of the plant.

As expressed by the author of the paper, there is a wonderful future in the refrigerating field, but before any great headway can be made, men must be developed, who can safely and economically operate the plants. The management must be educated as to what results might reasonably be expected and be made to realize the importance of proper selection, promotion, competition, training and salary based upon results. This in itself is a big task, worthy of the efforts of the various refrigerating and ice-making associations.

With plant examination and supervision where it is needed by well-posted refrigerating engineers, progress may be expected. This, of course, entails constant touch with the operating force by means of complete records and the checking of results from day to day. Inefficiencies will immediately show and may be corrected. From a study of existing conditions and the operating data, characteristic curves for each plant may be prepared. These curves should cover all factors relating to economy and should be used as a guide and basis of comparison for future operation.

Briefly, the engineer is the big factor in the problem. He may be educated as suggested in the previous paragraph, but until the management realizes the need of competent men and the necessity of salaries commensurate with their engineering knowledge, it is quite probable that the refrigerating plant will continue as a model of inefficiency.

Bonus for Power-Plant Employees

ON OTHER pages of this issue appears an article on "Bonuses for Power-Plant Employees," by Warren B. Lewis, a consulting engineer well known in New England and particularly familiar with mill power-plant practice in that section of the country noted for its industrial activity. The impressive feature of the article is its scope; the author embraces all power-plant employees as those who should share in the bonus. This, while unquestionably most equitable, is uncommon. Usually, bonuses are paid only to boiler-room crews on the assumption that they have greatest influence over the source of heaviest loss. Where a plant is large, and especially if it is one supplying heat and power, as to a bleachery or other large consumer of steam for industrial purposes, it certainly is best for the management to provide a bonus system wherein all power-plant employees will share in the savings effected.

Mr. Lewis says that because the employee (and he means everyone in the plant from the chief engineer down) shares in the bonus "does not mean that he is to originate the methods [of saving] to be employed." When considering the application of a bonus system to power plants, managers are too likely to predicate consideration on the premise that the employee should originate the means of saving. That is too often taken for granted. As saving, to the management as well as to the employees, is the prime object of paying a bonus, it is obvious that the method that gives the greatest return is worth while whether it comes through the management's own staff or after survey of the plant by a consulting engineer.

It is of interest that the system of paying bonuses, as told of by Mr. Lewis, presupposes that the management "include in the power plant all the equipment which in any way affects the use of fuel," and that when this is done "it becomes a comparatively simple matter to place upon the chief engineer the responsibility for the efficiency of the entire power-making and power-using equipment, and for its cost per unit of production." Needless to say, this assumes that the chief engineer be a high-grade man, one who is capable of meeting and discussing problems with department heads, who has a good working knowledge of relative values, of cost accounting and apportionment of charges —these along with a most thorough knowledge and understanding of his plant and of the availability of equipment, materials and supplies which the market affords. Even though the company retains a consulting engineer, these qualities in the chief engineer in charge are highly desirable.

Mr. Lewis is aware that many will criticize his accounting of power-plant performance on the unit of product of the works or mill turned out per unit of power-plant cost. But he meets the probable criticism very well, we think.

When Contracts Go Begging

During these days when everybody is talking in millions and even billions of dollars, the fellow with a few paltry thousands of dollars does not cut much of a financial figure, if the *Mining Journal*, of Marquette, Mich., is correct in the publication of an article relative to the placing of an order amounting to forty-five thousand dollars for new equipment. It reads as follows:

> The superintendent of the light and power department and the department's engineer have gone a-journeying to see if they can find anyone who will condescend to consider the small matter of an order for forty-five thousand dollars of electrical and hydraulic machinery. They have gone because their tentative inquiries among manufacturers brought, in most instances, no response at all, and in others only a languid interest. In normal times the announcement that Marquette was seeking to place an order for forty-fiv thousand dollars of machinery would have meant an eager charge on the city officials, by most resolute agents, and another besieging of the city hall during the period of consideration of the proffers, such as has frequently been seen in the past. But these are not normal times; they are war times. An individual, or city, that ventures to raise a voice about a mere matter of forty-five thousand dollars of machinery finds that he raises it in vain. The magic word "million," at least, has to be used to secure a hearing.

The foregoing is doubtless true at present, but there is coming a time when a forty-five thousand dollar contract for power-plant apparatus will look as good as a full coal bin did this winter.

The Alien Employee and the Labor Turnover

ONE of the most perplexing problems in industrial plants at the present time is that of the many millions of aliens now employed. This is a matter calling for careful and delicate handling, and it would be helpful to large employers generally to know what others are doing to solve this problem. The columns of *Power* are open to a discussion of this subject.

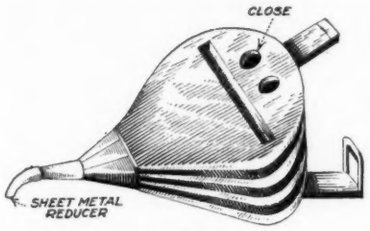
The excessive cost of labor turnover resulting from unsettled war conditions is another matter that is causing the employer considerable anxiety. Many plants find that costs run from ten to one hundred dollars for each employee broken in and that the annual total is enormous. What methods have you adopted to reduce this cost and what results are you getting? Give others the benefit of your experience through the columns of this paper.

The McGraw-Hill Company, Inc., publishes ten papers. Each of these papers has its own half dozen, more or less, distinctly separate departments, such as advertising, editorial, subscription, circulation, makeup, with one centralized mail department for all. It would considerably facilitate matters for those charged with expeditiously distributing to the proper persons or departments the hundreds of letters that come in daily, if our correspondents would remember to mention, when they know it, the name of the paper for which their communications are intended, as well as the department connected with it. Thus, for instance, matter addressed to Editor of *Power*, Advertising Manager, Subscription Department, etc., will be dispatched more quickly and have more prompt attention than that addressed merely to the McGraw-Hill Co., which has to be read through, very often passed through many departments and hands, previous correspondence, if any, looked up, and a great deal of valuable time and energy wasted that might otherwise be spared, in an effort to get it to the proper person to be efficiently and satisfactorily taken care of.

Correspondence

Removing Drill Chips by Vacuum

The following is a useful kink when drilling holes, reseating valves or similar work where it is difficult to remove the chips. On the nozzle of an ordinary molder's hand bellows solder a reducer of the size and shape desired and close up the regular air-inlet valves in the bellows. To operate, close the bellows, place the nozzle near the chips to be got rid of and open the bellows quickly. The rush of air will carry the chips into the bellows, after which they can be easily blown out again.



BELLOWS FOR VACUUM

W. H. BENNETT.

Mount Vernon, Wash.

A Wooden Tank Repaired

It does not seem that the wooden tank repaired as described on page 164 in the issue of Jan. 29, 1918, could be considered safe to have over one's head. Atmospheric moisture and minute seepage will collect between the cement coating and the wood, and it will not be long before the planks, weakened by decay, will give way under the load.

"Safety first" would surely require a new tank.

Lynn, Mass. P. P. FENAUX.

[The repair job referred to, when finished, would appear to be a concrete tank reinforced by the original planking banded with iron hoops. No doubt a time will come when the wood will have become decayed to such an extent as to afford no support or backing between the bands and the concrete, but this does not seem to be its present condition.—Editor.]

Care of Electrical Equipment in Cold Weather

A few words may be in order concerning the care of electrical apparatus, particularly motors and generators which are exposed during cold weather.

It is very easy for machines to get "wet" during cold weather, even though not exposed directly to rain or snow. Condensation is at the root of the trouble. If a cold machine is brought into a warm room, the atmospheric moisture condenses on the machine's cold surfaces, just as it does upon one's spectacles under similar conditions. It is possible for a great deal of moisture to be formed and absorbed by an electrical machine in this way. It may also happen that condensation will occur while a machine remains out of doors covered and unmolested, a sudden change from low to higher temperature being responsible. This is particularly liable to occur with large machines, the internal temperatures of which change but slowly.

The preventive of trouble lies in removing the cause. Store machines in a warm place if possible and do not move them from a cold into a warm place suddenly, but bring about the change gradually. If a machine is stored outside, protect it well and provide resistors or other means to keep it moderately warm, particularly whenever a change from cold to warm weather is expected.

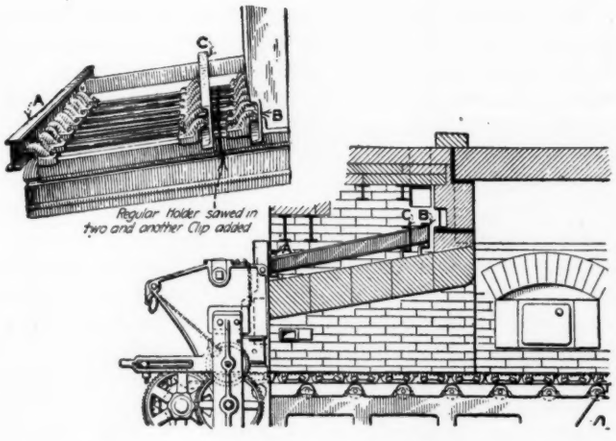
When a piece of electrical equipment has absorbed moisture, it should be dried out before use. The methods for doing this are quite familiar (see *Power*, p. 46, Jan. 8, 1918). The drying should be continued until insulation resistance, as measured by a megger or other means, indicates that the machine is in good condition again and safe for use.

GORDON FOX.

Chicago, Ill.

Holding Up the Curtain Wall of a Stoker

The illustration shows my way of holding the curtain wall of a Green chain stoker in place, independently of the arch. The old way was to use the channels marked *A* and *B* to hold the T-bars (suspended under them) on which the arch brick are hung and upon which the curtain wall is built. But when the arch burns out, down comes the curtain wall also. By adding another channel, marked *C* in the illustration, and cutting the T-bars and adding another clip, then bolting a 6-in. angle iron on the back of *B* so as to support the curtain wall independently of the regular support, the curtain wall will always be held in place and the arch can be replaced without disturbing it.



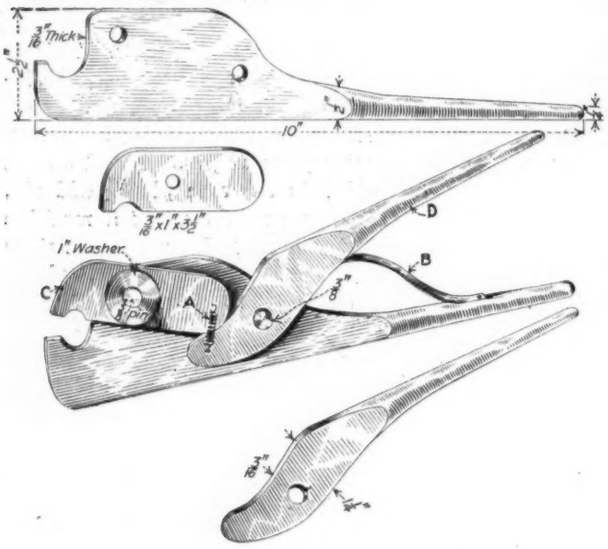
CHANGE IN SUPPORT FOR ARCH AND CURTAIN WALL

J. J. NEVILLE.

Chicago, Ill.

Cutter for Large-Sized Wire

Cutting iron wire or large copper conductors is impractical with shears and impossible with ordinary cutting pliers. A powerful and very compact cutter, which anyone can make in his spare time, is shown in the



PARTS AND ASSEMBLY OF WIRE CUTTER

figure. This tool is made of $\frac{3}{16}$-in. steel, hardened on the cutting edges, and will cut copper wire up to $\frac{7}{16}$ in. diameter, or even larger if the handles are made longer than those shown. The spring *A* holds the cutter *C* against the lever handle *D*, while the spring *B* holds the handles apart.

M. P. BERTRANDE.

Ozone Park, N. Y.

Combustion in Boiler Breechings

As considerable interest seems to be centered on the subject of combustion in the fuel bed of hand-fire furnaces and in the gas-producer action of fuel beds, and with explosions in boiler furnaces, I am telling the following points from experience in our boiler room.

When the writer took charge, two of the boilers were fitted with ordinary stationary flat herringbone grates and natural draft and two were fitted with a forced-draft system employing hollow grate bars through which the air was blown, the bars having narrow slots on the upper surface through which the air reached the fire. The breeching over the latter boilers was badly warped and showed plain signs of overheating.

It was soon found that when heavy loads were being carried, a gas flame was present in the breeching after every firing, gradually dying out as the fires burned clear. The coal used was of high volatile content and southern Illinois origin. The boilers were of the Heine type, and the baffling was in good condition, so that there was no question of the fire going directly through the tubes to the breeching. The firemen reported also that the furnaces would occasionally "puff" badly, especially if a door were opened wide a short time after firing.

The breeching not infrequently became red-hot, and because of the warping it did not make tight connections on top of the boilers. It soon became evident that the combustion of the gas was supported by the air drawn in at these openings. It was also found that the flame did not occur if the furnace doors were left open about an inch for a minute or two after firing. If the flame was permitted to start by keeping the doors closed, it could be extinguished at once by slightly opening them. This showed that the trouble was caused by insufficient air in the furnace. As long as we had the forced-draft grates, we kept the doors open a little for a minute or so after each firing.

The air forced into the furnace from the grates at high velocity made a very hot fire close to the grate, but it was not sufficient for complete combustion, and the fuel bed acted like a shallow gas producer. The flame in the breeching was caused by the burning of the producer gas so generated, enriched by the gases distilled from the green coal just after firing.

I believe that this condition is likely to occur in other hand-fired forced-draft plants and that it would be well for operators of such plants to be on the lookout for trouble in this direction.

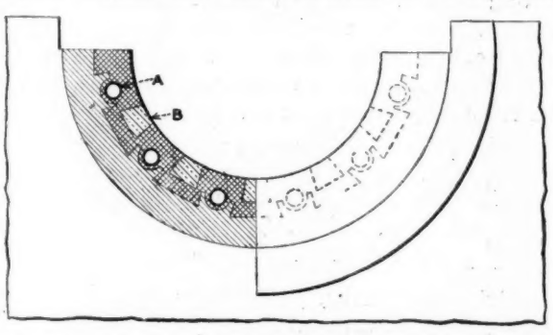
C. H. SONNTAG.

Cape Girardeau, Mo.

Hot Gas-Engine-Bearing Remedy

On a 1200-kw. gas engine direct-connected to a generator, the main bearings ran hot although they were water-cooled by means of a series of brass pipes shown at *A* in the figure. The pipes were connected by return bends and embedded in the babbitt metal.

We tried different mixtures of babbitt in the bearing and various pressures on the cooling water, but these did not remedy the trouble, the worst part of which was that the babbitt wore down quickly, throwing the generator's armature out of the polar center, consequently changing the magnetic pull between the field poles and the armature. We finally made a series of soft-bronze grids, or strips *B*, and poured the babbitt around them as shown. The bearings, where necessary, were scraped to a good fit. Since making this improvement, no trouble has been experienced. These strips



SECTION THROUGH GAS-ENGINE BEARING SHOWING LOCATION OF BRONZE STRIPS

help the babbitt to stand up under the heavy pressures, and the babbitt particles embedding themselves in the bronze faces form an excellent lubricant.

I would like to hear an expression of opinion from *Power* readers on why the bronze strips are so effective in remedying the trouble. I believe that mixed-metal bearings have proved very satisfactory where used.

Chicago, Ill.

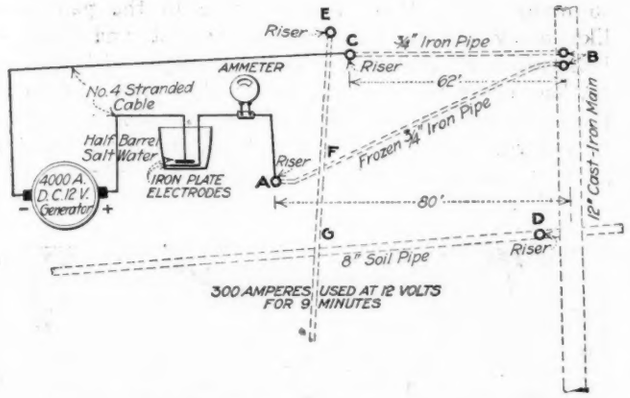
C. A. MERTON.

Thawing Frozen Water Pipes by Electricity

During periods of extremely cold weather the frost penetrates deeper into the earth than usual and frequently freezes embedded water pipes that are ordinarily considered as being below the frost line or pipes which under normal cold-weather conditions would be protected by means of wrappings, conduit, etc. In and around the plant it is generally easy to get enough heat to thaw a frozen pipe, but the first problem is to get into contact with the pipes in order to concentrate the heat so as to make it effective.

It is no easy job to dig down through two or three feet of frozen earth or tear out insulating coverings to get at piping; in fact, by far the greater amount of time and labor is employed in getting at the pipes so that the actual thawing may be done.

For such cases as the foregoing, the electrical method of thawing saves all this unnecessary labor. Many



LAYOUT OF PIPING AND THAWING EQUIPMENT

power-plant engineers are aware that pipes are being successfully thawed by electricity, and while they have knowledge of its being done in the cities by lighting and power companies, it is associated in their minds with special apparatus and transformers and with the belief that alternating current is necessary.

It is preferable to use alternating current for this work, because greater amperage can be obtained from commercial circuits by means of a step-down transformer. The use of the transformer in the electrical system charging the pipe line also insulates the high-voltage circuit from the low-voltage, thereby reducing the danger of shock and grounds with gas piping, etc. However, direct current can well be used because it is the heating effect only that is required.

The necessary equipment to use a direct-current circuit for thawing water pipes consists of a water rheostat, which may be a barrel of salt water with two electrodes made of pieces of iron plate or other metal and a length of stranded cable sufficiently heavy to conduct the current used without excessive loss. An ammeter is also desirable, since too great a current may damage the piping.

Data on the number of amperes and the time required is likely to be misleading, for the reason that all the current may not traverse the pipe being thawed as there is liable to be current leakage through the damp earth to other piping. For instance, in a particular case in which an electroplating generator was used to supply 300 amperes at 12 volts, it was estimated that 50 amperes was bypassed, therefore only 250 amperes was used effectively. The apparatus used consisted of a water rheostat made from a half-barrel filled with salt water, two 9 x 12-in. iron plates for electrodes, about 75 ft. of No. 4 stranded wire and an ammeter. The entire length of the circuit was about 230 ft., and the time to produce running water was 9 minutes.

The figure explains the conditions of the case in question. Pipes *AB* and *CB* were tapped directly into the 12-in. main. The vertical distance between any two pipes was small and all were from two to three feet below the surface. At *C* the ¾-in. riser terminates in a sink without sewer connections. The pipes were not disconnected from the risers for the reason that all were short runs. *A* terminated at a humidifier on the second floor of the building and was practically insulated from the earth, thereby presenting an isolated condition. This was also true of riser *D*, which terminated in a watering trough. The water rheostat was short-circuited when the current was in use.

Meter readings taken from *A* to *D* and *D* to *B* showed that there was considerable current leakage, and it was estimated that about 50 amperes was diverted by way of *F*, *G*, *D* and *B*. However, in this case the freezing was between points *A* and *F*, therefore the leakage was of no consequence. The following figures were obtained in connection with an alternating-current portable pipe-thawing outfit operated by a central-station company. The primary of the transformer was connected to their distributing line and the 110-volt secondary to the pipes to be thawed on the premises.

Size of Iron Pipe, Inches	Length	Amperes	Volts	Time in Minutes
¾	60	350	110	20
1	70	300	110	30
1¼	100	150	55	12
1	250	480	50	15

The writer has also used a 200-ampere-hour 12-volt storage battery for thawing water pipes with satisfactory results.

MATHEW KING.

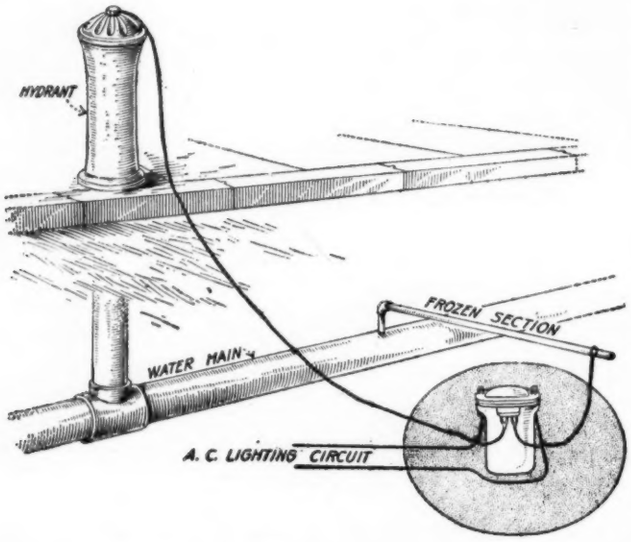
Passaic, N. J.

It is quite generally known that a heavy current of electricity passing through a frozen water pipe will heat it sufficiently to melt the ice. It is not, however, so generally known that enough current can be taken from an ordinary lamp socket to accomplish this result provided the circuit is an alternating-current one and a small transformer is available.

The writer recently thawed out a ¾-in. service pipe, which was frozen solid for a distance of about 25 ft., with a 5-ampere current at 110 volts, taken from a house circuit. The current was passed through a 500-watt transformer having a 1 to 12 ratio, thus delivering at the secondary a current of approximately 60 amperes. The secondary wires were connected directly to the frozen pipe line and hydrant, as shown in the figure so as to include the frozen section between the connections. No resistance was necessary on account of the low voltage of the current. The current was left on for nearly two hours before water came, but the time required was longer than it otherwise would have

been on account of it being necessary to make one connection to a hydrant 150 ft. away from the frozen pipe, as a connection with the frozen section could not be had in less distance without digging in the ground. This, no doubt, caused considerable leak of current through the ground that otherwise would have passed through the frozen pipe.

Any small transformer having a capacity of 500 watts or more will do the trick. An ordinary sign-



TRANSFORMER CONNECTION FOR THAWING FROZEN SECTION OF WATER PIPE

lighting transformer of 500- or 750-watt capacity is convenient, and is also useful for other purposes, and the cost is only slightly more than an electric-light company charges for one thawing job.

These transformers are foolproof, and there is not the slightest danger in using them. They can be short-circuited on the secondary side without injury. They take current from a lighting socket on the primary side at 110 volts at about 5 to 8 amperes, and deliver current on the secondary terminals at 10 volts and from 50 to 75 amperes. They may also be obtained for use on a 220-volt circuit. A 10-ampere fuse should be used in the circuit on the primary side, and if this blows the current must be kept down by means of a water rheostat connected in series in the circuit, so that a new fuse won't blow.

The water rheostat need only consist of an iron bucket to which one wire is attached and the other wire connected to a piece of metal and placed in the center of the bucket in the salt water with which the latter is filled. The current can be increased by moving the metal electrodes toward the side of the bucket.

Care should be used to see that the pipe to be thawed is disconnected from all other piping in the building. If this is not done, there is a possibility that the major portion of the current may be bypassed around the freeze and the job will be a failure or require considerable more time than necessary.

If alternating current is not to be had, one or more 110-amp.-hr. storage batteries can be utilized at a high discharge rate, but care should be taken not to use a rate which would damage the batteries. Slight freezes can be taken care of in this way, but several batteries would be needed if the heating required more than half an hour.

WILLIAM R. BRYANS.

New York City.

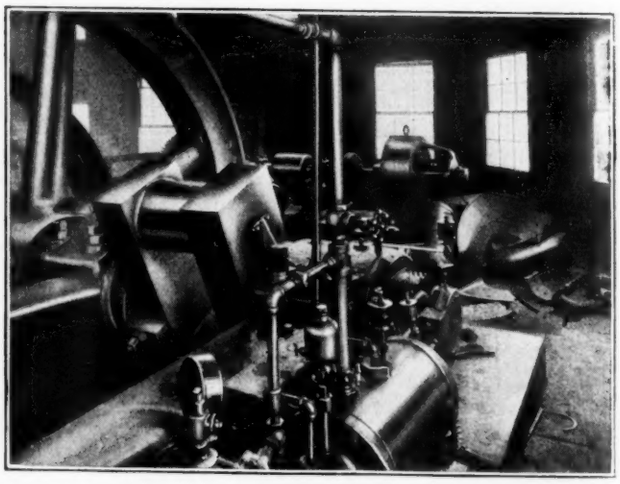
Repairing a Steel Stack

Some time ago in our plant a steel stack rusted off at the base, and we were confronted with the problem of how to put in a new section without taking down the whole stack. The difficulty was overcome by building a scaffold around the stack and lifting it by a block and tackle to a sufficient height to allow the new section to be put in; then the top part was let down and riveted to the new section, thus making the repair without the extra work of lowering and raising the entire stack.

Philadelphia, Penn. D. R. HIBBS.

Piston, Striking Head, Wrecks Engine

The engine wreck shown in the illustration is similar to many others that have occurred in the past and, like many others, was due to neglect and lack of lubrication of the main-crank bearing, which caused the engine in time to get too much lateral motion in the main moving parts and allowed the piston to come in contact with the cylinder head, resulting in the general wreck, as shown. The engine cylinder was 16 x 24 in., the speed 150 r.p.m. and the working com-



WRECK CAUSED BY PISTON STRIKING CYLINDER HEAD

pression 260 lb. The balance weights, which were distributed over the plant, weighed approximately 3600 lb., and a connecting-rod, which was thrown some distance, weighed about 1500 lb. The accident not only wrecked the machine as shown, but cracked the main bedplate in several places.

C. R. MCGAHEY.

Atlanta, Ga.

It is better to wear a Liberty Bond button on your coat than the print of the Kaiser's heel on your neck.

Do you believe in Democracy? Do you believe in America? A purchase of a Liberty Bond is a test of your faith in American Democracy.

When you lend money to the Government it does more for you than you do for it. The Government pays good interest and protects your life and property.

Inquiries of General Interest

Burning of Clean Water Tubes—What would cause clean tubes of a water-tube boiler to become burnt or blistered below the water line of the boiler? L. G.

The material of water tubes or other heating surfaces of a boiler is likely to become burnt when the fire is driven so hard that the rapid generation of steam drives the water away from the heating surface, as that condition causes the surface to become overheated from much slower transfer of heat than when the water is directly in contact with the heating surface.

Mean Forward and Mean Effective Pressure—What is the meaning of "mean forward pressure" and "mean effective pressure"? W. P. S.

"Mean forward pressure" is a term used to designate the average pressure acting on a piston with a tendency to move it forward, or in the direction corresponding to that necessary for performance of useful work. It is the reverse of mean back pressure, which is the average pressure that resists the motion of a piston in performance of useful work. "Mean effective pressure" is the mean net pressure that urges a piston forward, and therefore is equal to the mean forward pressure minus the mean back pressure.

Inches of Water Pressure—What is meant by an inch of water pressure; and how many pounds or ounces per square inch would a pressure of 2½ in. of water be equivalent to? N.A.

An inch of water pressure signifies the intensity of pressure due to a column of water 1 in. high. As 1 cu.ft. of water at 62 deg. F. weighs 62.355 lb., the weight of 1 cu.in., or the pressure per square inch exerted by a water column 1 in. high, would be $62.355 \div 1728 = 0.03609$ lb. Hence 2½ in. of water pressure would be equivalent to $0.03609 \times 2\frac{1}{2} = 0.09022$ lb. or $0.09022 \times 16 = 1.4435$ oz. per sq.in.

Discharge from Broken Gage-Glass—If in case of breakage of a water-gage glass of a boiler under steam, the top connection is closed but the bottom connection cannot be closed, would escape of hot water and steam from the broken glass be prevented by opening the valve on the blowoff pipe to the column or glass? H. W.

Discharge from the broken glass would not be prevented, as opening a blowoff valve would relieve only part of the pressure holding the water up in the column. The water level in the column would become lower and as soon as the level dropped below the open gage-cock, steam would blow through the cock and it would be discharged from the broken gage-glass at the full pressure of the boiler.

Exhaust-Steam Heating with Back-Pressure Valve Open—Can an exhaust-steam heating system, supplied with exhaust from a noncondensing engine, be operated with the exhaust back-pressure relief valve left open? C. P. C.

The purpose of a back-pressure relief valve is to hold sufficient pressure to satisfy the heating system, to relieve excessive back pressure and to act as a check valve to prevent admission of air in case the heating system draws the pressure below the pressure of the atmosphere. Hence the back-pressure valve may be left open so long as the pressure of the exhaust at the point where the heating supply is taken off is high enough for the heating apparatus, or the effect of the heating apparatus is not to reduce the pressure at the back-pressure relief valve below the pressure of the atmosphere.

Setting Valve of Single-Valve Automatic Engine—What is the method of setting the valve of a single-valve automatic shaft-governor engine? J. W. M.

The valve setting will consist mainly of adjustment for equalizing the cutoff. If cutoff takes place earlier on one end of the cylinder than the other, then with other portions of the valve gear properly assembled, the cutoff can be equalized by lengthening or shortening the valve-rod connections to obtain diagrams that would be desirable when the engine is driving the average load. If indicating is not available, the cutoff can be approximately equalized by blocking the governor to a position of about one-half its range of motion and adjusting the valve-rod connections to obtain closing of the steam valve at the same fraction of stroke from both ends, when the engine is turned over.

Kerosene as Boiler-Scale Remover—What are the advantages and disadvantages of using kerosene for removing scale from a boiler?

In cases where boiler scale is of such a nature that it can be softened by introducing kerosene along with the feed water, the oil has the advantages of being a cheap and conveniently applied scale remover. The leading objections to its use are that the presence of oil in a boiler is likely to cause leaks at joints and rivets; steam-joint gaskets of rubber and many other materials disintegrate and leak from presence of oil; and deposits of heavier oils may be formed which, combining with material contained in the feed water, may cause the heating surfaces to become burned. Boilers containing traces of mineral oils, especially when the oil has been liberally added to the feed water, should be thoroughly washed, drained and ventilated before being entered, as highly inflammable hydrocarbon gases are likely to be present.

Failure of Corliss Engine-Governor Belt—What would result if the governor belt of a Corliss engine should break or come off the pulley? W. F.

The governor would stop, and with the governor balls no longer acted upon by centrifugal force, they would drop to a position of support. If permitted to drop to the very lowest position for which the governor is designed, the safety cams, if properly set, would be drawn around to a position for which the steam admission valves are not opened, and the engine would come to rest. But if the governor is hindered from dropping far enough to bring the safety cam to this position, as for instance, from resting on the starting pin or other device used to support the governor for holding it up to a starting position, then the valves will be operated to admit steam without the governor's regulation of the cutoff. Under these conditions, unless the supply of steam is shut off by hand or by some form of automatic safety stop, the speed is likely to increase sufficiently to wreck the engine.

Drilling and Reaming Boiler Rivet Holes—Why are boiler rivet holes required to be drilled or reamed in place of punching the holes to size? J. R. L.

Punching lessens the tensile strength of the material around the holes, and the pressure of the punch, and difference of diameter of the punch and die, cause jagged-edged holes and burrs that reduce the holding power of the rivets. In addition to this, holes punched in two or more thicknesses that are to be riveted together seldom come in correct register. By first punching the holes smaller than required for receiving the rivets, the rough edges and distorted material can be removed by drilling the punched holes to size, and the holes of two plates that are to be riveted together may be brought into alignment by drilling the holes full size with the plates bolted in position. The strength of the remaining material is considered to be unimpaired for plates over ⅜ in. thick when the diameter of the punched holes does not exceed ¼ in. less than the finished diameter, and for plates not exceeding ⅜ in. thick, when their diameter does not exceed ⅛ in. less than the finished diameter.

ERRATUM: The result of the computation given in the first item, page 377, Mar. 12 issue, as "about 9000" should have been "about 49,000 lb. of steam per hour."

Coal Saving by Lighting Curtailment*

By PRESTON S. MILLAR

The author points out that the coal used in the production of electric light is less than 2 per cent. of the total coal output of the country, and that any practical curtailment is about 7 per cent., which means about 840,000 tons of coal per annum, or a trifle more than 0.1 of 1 per cent. saving. It is possible to effect much larger savings by other methods with less disadvantage to the public.

THE most important thing is to win the war. Need for directing money, energy and materials toward the prosecution of the war makes it imperative that waste and extravagance be eliminated. The first consideration is how best to contribute to victory. Economy, in lighting, as in other things, is one means toward that end. Economy in lighting in the present circumstances depends upon:

Securing best accomplishments of the results which the lighting is intended to bring about, subject to the need for reducing the consumption of fuel by the elimination of unnecessary lighting and by reduction of other lighting so far as the emergency warrants. Emergency reduction should be undertaken after due consideration of:

a. The amount of fuel saving that can be accomplished.
b. The disadvantages involved in the reduction.
c. The practicability of saving the same amount of fuel otherwise with less disadvantage.

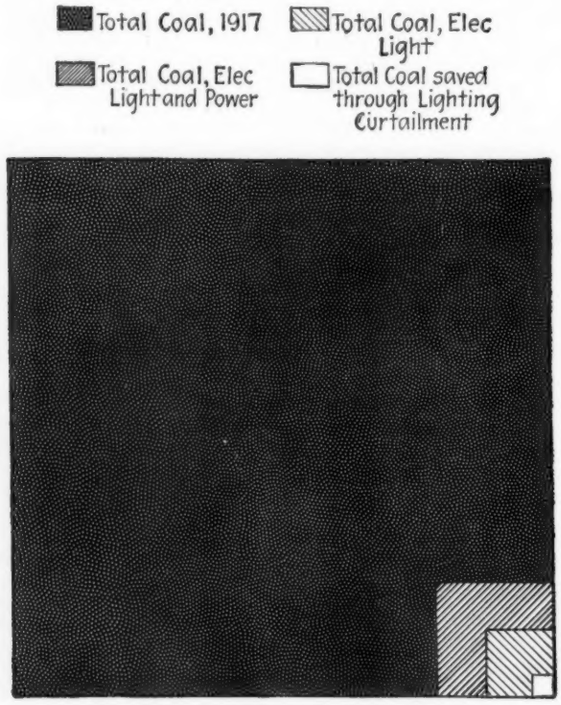


FIG. 1. TOTAL COAL PRODUCTION AND COAL CONSUMPTION OF THE COUNTRY FOR LIGHT AND POWER

The cost of artificial illumination of all kinds is 0.5 to 2 per cent. of the total expenditure of the people. It compares with certain other expenditures as follows: Illumination, $500,000,000; liquors, $665,000,000; and tobacco, $490,000,000.

The significant figures to have in mind in discussing this subject are as follows, all being rough approximations: Total coal output of the country, 640,000,000 tons; total employed in production of electric light and power (traction excluded), 36,000,000 tons; total employed for production of light by electricity, 12,000,000 tons. According to these estimates, about 2 per cent. of the coal consumption of the country goes into electric light. Fig. 1 gives a graphic comparison between the foregoing figures and the estimated coal saving possible by lighting curtailment.

Some comparison may assist to provide a proper perspective for the consideration of these data. Coal shortage, the equivalent of which must be saved, 50,000,000 tons, estimated savings in coal during 1914 if all private plants could have been replaced by central-station power, 13,000,000 tons. Estimated saving in coal by maintaining temperature of building interiors at 67 deg. F. instead of 70 deg., 10,000,000 tons.

It is evident, therefore, that the total consumption of coal in the production of all electric light is relatively not a very large item in the coal consumption of the country. If the entire electric lighting of the country were cut off, the saving in coal would be only 24 per cent. of the required saving, and no more than would be accomplished by a reduction of readily practicable extent in the heating of buildings. In considering lighting curtailment, therefore, it is important to bear in mind that even if every candle power of electric lighting were wasted, the loss of coal involved would not be the great outstanding coal waste of which this country is guilty. As relatively little light is wasted, it is evident that the amount of coal which can be saved by electric-lighting curtailment is small.

RECOMMENDED ADJUSTMENT OF ILLUMINATION INTENSITIES IN VIEW OF THE WAR AND THE FUEL SHORTAGE

Class of Lighting Service	Per Cent. Distribution	Desirable Adjustments in Intensity Per Cent.
Street	15	— 5
Public building	3	— 10
Industrial	18	+ 50
Protective	1	+200
Commercial	20	— 20
Residence	26	— 20
Recreational	7	— 40
Advertising	5	— 80
Miscellaneous	5	— 10
Total	100	Net — 7

The author has prepared the rough estimate given in the table, showing the adjustment of illumination intensities, which according to expert opinion of several men engaged in the lighting business ought to be made from standards existing before the war, in view of the war and the coal shortage. The table also shows the manner in which artificial lighting is distributed among the several classes of service adopted as a classification for this purpose. There are no general statistics on this subject. Therefore, these figures should not be accepted as anything more than a rough approximate, although they are probably reasonably indicative of expert opinion on this subject at the present time.

The first adjustment of artificial lighting which ought to be made at the present time depends on the one hand upon the need for obviating extravagant lighting and eliminating waste, and on the other hand upon the importance of promoting industry and safeguarding lives and property. The net adjustment based upon the estimates of opinions summarized in the table is in the order of —7 per cent. Adjustment in particular classes of service range from a maximum curtailment of —80 per cent. in advertising lighting to a net increase of 200 per cent. in protective lighting. In the opinion of lighting experts, electric lighting, which to obtain most desirable value ought to be increased by 73 per cent. before the war, ought now to be decreased by 7 per cent.

*Abstract from a paper presented at the special meeting of the Illuminating Engineering Society in New York City on Feb. 14, 1918, and at a meeting of the Philadelphia section of this society on Feb. 15, 1918.

Various methods of reducing artificial lighting as a war measure have been proposed as follows:

Remove unnecessary lamps, extinguish all lamps when they are not in use, extinguish some of the lamps when possible, substitute smaller sizes of lamps, and replace inefficient by efficient lamps.

There is every reason for emphasizing the desirability of eliminating the unnecessary use of light. Fuel administrators and lighting companies have urged this expedient very prominently. Bulletin V of the Committee on Coal Conservation of the Chamber of Commerce of the United States, entitled "Conservation in Use of Coal," is an excellent presentation on this general subject which should be distributed generally.

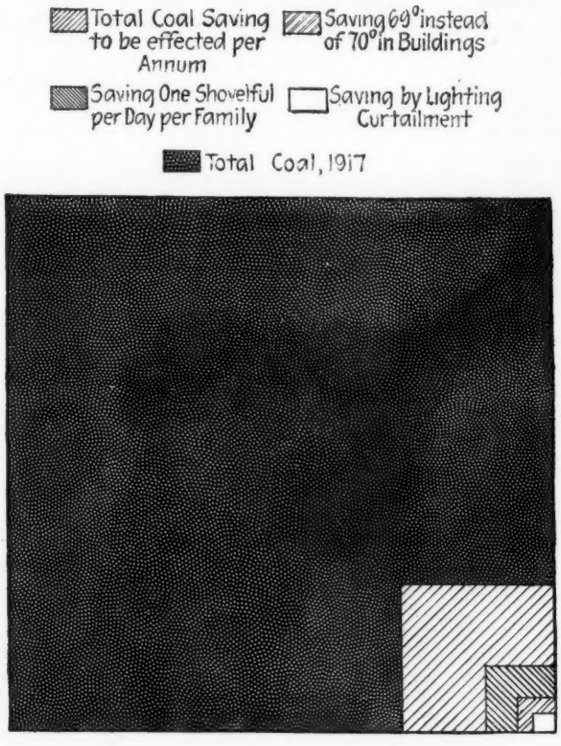

Total Coal Saving to be effected per Annum
Saving 69° instead of 70° in Buildings
Saving One Shovelful per Day per Family
Saving by Lighting Curtailment
Total Coal, 1917

FIG. 2. TOTAL COAL PRODUCTION AND COAL SAVINGS BY DIFFERENT CURTAILMENTS

To arrive at suggestions for saving fuel used for lighting purposes without deleterious effects, one should consider the elements of inefficiency in lighting and the possibility of eliminating them. Such a line of consideration brings the following to the fore:

Good utilization of light, good maintenance of lighting equipment, use of good reflecting surfaces, daylight saving, utilization of water power, and elimination of small power plants.

The adoption of summer daylight saving, as now proposed, is estimated to be capable of reducing the coal consumption of electric central station steam plants by 230,000 tons per annum for the entire country. A suggestion to advance the period of activity by one hour the entire year round, which is now attracting considerable attention, is estimated to afford about the same saving to the public in lighting bills, but to result in a somewhat greater saving of coal on account of the more favorable load factors for the power plants, which would result in the winter months.

The inherent lower efficiency of small plants, together with less expert operation, which in general they receive, is estimated to be responsible for the use of one-third more coal than necessary. This element of waste is even more serious in England than in this country, as is evidenced by a recent report (April 16, 1917) of the Coal-Conservation Sub-Committee of the Reconstruction Committee, in which, after pointing out that the average capacity of English generating plants is 5000 hp., it is stated that "the present coal consumption if used economically would produce at least three times the present amount of power."

If a proportional amount of coal saving equivalent to 7 per cent. of the total electric light produced be assumed, this would mean a reduction in coal consumption of 840,000 tons per annum. This is the maximum extent to which it is believed that the best interests of the public requires coal to be saved through electric-light curtailment. Such a saving compares with other possible annual savings as follows:

Total savings which must be accomplished, 50,000,000 tons; net savings thought desirable through curtailment of electric lighting, 840,000 tons; savings if one degree lower temperature is adopted for building interiors, that is, 69 instead of 70 deg. F., 3,000,000 tons; and saving if each family decreased by one shovelful its daily use of coal, 15,000,000 tons. A graphic comparison of these figures is given in Fig. 2.

The saving which is possible in the heating of buildings looms large. Our practice in this respect is to heat buildings to a considerably higher temperature than is done in Europe. The coal which might be saved by operating buildings at temperatures which prevail in Europe, instead of at the temperature which we affect, would be more than the equivalent of the entire consumption of coal in electric lighting. Even the saving of one shovelful of coal per day makes any practical saving through electric lighting curtailment seem very small

New York State Legislation Affecting Power Interests

A synopsis of the more important bills affecting power interests introduced in the Legislature at Albany follows:

Senate Print No. 1. Amending the Public Service Commissions law, by providing that whenever a gas or electric corporation or a municipality files with the commission a new schedule of rates or a change in form of contract as to rates, service or facilities, the commission may, upon complaint or of its own initiative and upon notice, hold a hearing concerning the propriety of the proposed change and pending a decision may suspend it for not exceeding 120 days from the date when it would otherwise take effect. On Feb. 13 this bill was on the calendar in the Senate for final passage, but was recommitted to the Public Service Committee and has not since been called out.

Senate Print Nos. 66, 67 and 68 are three companion bills providing for the erection of a state owned and controlled hydro-electric power plant at Niagara Reservation. They provide for the issue, after approval by a referendum, of $3,000,000 of tax-exempt bonds, empower the Niagara State Reservation to construct such power plant and to operate it under their own management or under lease and provide for the manner of construction. Neither one of the measures has as yet been reported for consideration.

Senate Print No. 271. Amends the Public Service Commissions law relative to complaints as to quality and price of gas, by providing that upon written petition of not less than 100 users of gas or electricity in first- or second-class cities, and not less than 50 such users in third-class cities and 25 elsewhere, the mayor, village trustees or town board, as the case may be, must complain to the proper commission regarding the matters specified in the petition. This bill has not been acted on in the Senate. The same bill introduced in the Assembly under print number 404 on Mar. 7 was reported to second reading.

Senate Print No. 475. Amends the Public Service Commissions law by empowering the commission to raise or reduce rates and charges for gas and electricity, notwithstanding a rate may be fixed by statute or otherwise. No action has been taken on this measure.

Senate Print No. 428. Creating a state hydro-electric power commission to consist of the Governor or a representative appointed by him, Lieutenant-Governor, Attorney-General, State Engineer and the Conservation Commissioner, to investigate costs and method of development, transformation, transmission and distribution of the water powers of the state, formulate a definite and fixed policy

of utilizing same, including canals; prepare and recommend proper legislation for carrying out such plan and urge upon the Federal Government proper recognition of the state's inherent right to full control of the boundary waters; and may authorize the Attorney-General to bring action against the Federal Government to determine such rights. One hundred thousand dollars is appropriated. The commission may maintain a bureau at Washington, D. C. This bill is the result of the labors of the Thompson water-power investigating committee which has been busy the last two years. At this writing it cannot be determined what action the Legislature will take in regard to the passage of the measure.

Senate Print No. 430 authorizes the Superintendent of Public Works with the approval and direction of the Canal Board, to lease the use of surplus waters impounded by canal dams and flowing into canals; authorizing the Canal Board to compromise and adjust claims and demands of water-power claimants and owners of water-power rights and privileges, appurtenant to state canal dams, constituting part of improved canals. The surplus waters of canals are to be leased to the highest bidder whether it be a person, corporation or municipality. Leases must not be for less than the appraised value of such water, and every ten years the value is to be reappraised. The Legislature has taken no action on the passage of this measure, but it will undoubtedly come up for discussion before the adjournment.

Senate Print No. 542. Authorizes the state through the Canal Board to build and equip canal boats and other craft, or to purchase or lease them for a period not longer than one year after the war. The state may lease such craft to individuals or corporations for operation or may operate them itself through the Department of Public Works, which is empowered to fix transportation rates. The Canal Board may organize one or more stock companies for constructing, purchasing or leasing such craft and for their operation, the aggregate capital not to exceed $2,000,000. If the state remains stockholder, it must retain at least 51 per cent., selling the remainder to the public at par. The Canal Board may with the governor's consent sell the entire issue to the public. One million dollars is appropriated. This measure is said to be favored by the Governor and will undoubtedly meet with the serious consideration of the Legislature before its adjournment. It bears upon the question of transportation and coal supply.

Senate Print No. 597. Amends the second-class cities law by permitting a municipality to construct, own, maintain and operate an electric power plant with necessary equipment for supplying electric power and light to the municipality itself.

Senate Print No. 744. Amends the railroad law by prohibiting the use of a locomotive engine not equipped with a vestibule cab so constructed as to attach to the sides of and inclose all openings between the engine cab and the water tank or coal tender. It strikes out the provision that mechanically operated doors are not required on doors of locomotives equipped with mechanical stokers. This bill has not been reported from committee.

Senate Print No. 747, by Senator Wagner, is a municipal-ownership public-utilities bill introduced as the outgrowth of campaign pledges in the recent New York mayorality campaign. It amends the general city law giving all cities power to own, construct, acquire, purchase, maintain and operate plants, facilities and property of every kind for supplying light, heat, power and transportation for both municipal and private use. Intention to exercise such power must be evidenced by resolution of the local administrative body declaring it in the public interests to do so and giving general description of the facilities or property to be constructed or acquired. The propositions must be submitted to the electors of the city. The value of the property to be acquired must be ascertained in the first instance by the Public Service Commission. There are various other provisions. What action the Legislature will take on this bill is largely a matter of conjecture.

Senate Print No. 842. Amends the labor law by extending the provisions for boiler inspection by the Industrial Commission to include all boilers for generating steam or heat, which carry a pressure of over 15 lb. to the square inch instead of 10 lb. as at present, and whether used for factory purposes or otherwise, except boilers subject to inspection by the United States Government or Public Service Commission; requiring such inspection at least once a year.

Senate Print No. 889. Amending the Public Service Commissions law by authorizing incorporation of gas corporations for acquiring natural gas and distributing and selling same, giving such corporation the right to acquire necessary artificial gas to augment its supply by purchase, manufacture or otherwise, and empowering the public service commission to order such augmentation when necessary for adequate service to customers.

Senate Print No. 902. Amending the Public Service Commissions law by requiring the commission to establish gas-testing stations for each individual gas corporation at points remote from the gas plants, and providing a schedule of fines based on the percentage of inferiority in gas, such penalties to be in the form of rebates to the customer.

Assembly Print No. 54. Amending the Transportation Corporations law by prohibiting electric-light corporations from collecting rent from meters. This law already applies to gas meters.

Assembly Print No. 472. Appointing Benjamin B. Odell State Ice Comptroller and regulating the storage and distribution of natural and artificial ice. It prohibits the manufacture of artificial ice in New York City, on Long Island and the counties bordering the Hudson River between Mar. 1, 1918 and Feb. 1, 1919. This bill passed both houses of the Legislature and became Chapter 4 of the Laws of 1918.

Assembly Print No. 645. Amends the conservation law by creating a division of hydro-electric power in the conservation department. This is a socialist measure and calls for the development of the Niagara River, the Long Sault Rapids and all inland waters and streams. Twenty million dollars of 4½ per cent. bonds are to be issued if the people approve of their issue at a referendum to be submitted to them this fall. The measure has to pass the Legislature, however, before it can be thus submitted.

Assembly Print No. 346. Provides for a terminal improvement commission in New York City, consisting of the mayor and comptroller, two public-service commissioners, First District, designated by the Governor, and three other members appointed by the Governor with the consent of the Senate to adopt plans for comprehensive terminal facilities for freight and for terminal markets in Manhattan. The commission may enter into an agreement with the New York Central and other transportation corporations, or if an agreement cannot be reached it may order compliance with plans adopted by it. The commission may order joint usage of facilities by different corporations. Until the Legislature determines that adequate terminal facilities have been completed, the commission is to exercise all the powers of the Public Service Commission over such terminals in Manhattan. When so completed the commission's existence is terminated. Provision is made for the condemnation of property, lease or exchange of lands with city, and for enforcement by courts.

Assembly Print 1098. Empowers the Public Service Commission by order to require two or more telephone corporations to establish continuous and through lines of communication, as in the case of telegraph corporations as at present.

Assembly Print No. 334. Empowering the Public Service Commission to raise or reduce rates and charges for gas or electricity, notwithstanding a rate may be fixed by statute or otherwise.

Steam Heating at Camp Funston

Before the Kansas City Chapter of the American Society of Heating and Ventilating Engineers, B. Natkin read an interesting paper on "Heating of Army Camps and Cantonments," dealing in particular with the installation at Camp Funston. Of the 16 National Army cantonments the following four are mainly heated by steam: Camp Custer, of Michigan; Camp Devens, of Massachusetts; Camp Funston, of Kansas; and Camp Grant, of Illinois.

All were installed under the same general plan with minor alterations to suit local conditions, so that a description of the heating plants at Camp Funston will practically apply to the other three camps.

Camp Funston is situated three miles from Fort Riley in the central portion of Kansas on a Government reservation of about 1200 acres. There are erected on these grounds 1400 wooden buildings, inclusive of barracks, latrines, medical quarters, officers' quarters, stables, garages, heating plants, exchange stores, warehouses and amusement buildings. Of this number, 650 buildings are heated from a central steam plant, while the balance have individual plants, stove or furnace heat, with the exception that the stables, garages and warehouses have no heat.

For heating these buildings there are 18 separate boiler plants, each taking care of about 35 buildings. Steam is supplied by a system of overhead mains supported on poles, and the condensation from each building is wasted. Steam in the main line is carried at 50-lb. pressure and is reduced at each building to about 5 lb. A 2½-in. reducing valve is used in each barrack and two 1¼-in. valves in each latrine, one for the radiators and the other for the hot-water tank. There is a total of 965 reducing valves in the camp. The poles are 20 ft. apart, and the steam main is suspended about 15 ft. in the air from trapeze hangers. The average size of the main is about 5 in. and the average run is 1200 ft. The drop in pressure at the end of the main is about 20 lb. Expansion is taken care of by slip joints at 200-ft. intervals. Branches to the various buildings are taken off at the bottom of the mains. By this means the lines are drained approximately every 75 ft. The steam mains are covered with 1 in. of asbestos air-cell covering, then 1¼ in. of wool felt, over which is wrapped waterproof roofing paper securely wired.

Overhead lines were used in preference to underground because this system was cheaper to install, could be readily got at for repairs, and material could be obtained more readily. As no return-line system was installed, a single line served the purpose. If the system was laid underground it would necessitate miles of trenching, suitable underground covering, such as wood log or insulated tile, a parallel return main with traps to take off the condensation in the mains and a drainage system for keeping the line dry. Then there would be the greater difficulty of repair. The condensation in the overhead line is little greater than generally occurs in an underground line.

Lack of an abundant supply of water, together with its large percentage of scale, has made it necessary to install a return-line system to save the condensation. These lines are now being installed. They run to a central low point in each unit, where the condensation is collected by an electric-driven pump and receiver, which in turn discharge the water to the boiler room. It is quite probable that had the Government engineers foreseen this necessity of underground return lines, they might have put the steam lines also underground, as it would have proved less expensive than the present system of overhead lines and underground returns.

Each boiler house has four 72-in. x 18-ft. hand-fired tubular boilers rated at 150 hp. each and served by individual 34-in. steel stacks 60 ft. high. Each plant takes care of about 35,000 sq.ft. of radiation, there being a total of 600,000 sq.ft. in the 18 units. Outside of the boilers, the only equipment in the boiler house is a 6 x 4 x 6-in. duplex boiler-feed pump and a small heater built of 8-in. pipe utilizing the exhaust steam from the pumps. Three boilers are fired as a rule, with the fourth in reserve for extreme cold weather.

The organization used to handle the central plants at Camp Funston is made up as follows: Two firemen are employed for each boiler, each man taking his turn for a twelve-hour shift. Two foremen are employed to watch groups of three plants. Over the foreman is the superintendent of the heating plants, who works under the head of the Department of Camp Utilities. The civilians employed in the various boiler plants are fast being replaced by soldiers, who will eventually handle the plants.

Barracks are two-story buildings 140 x 43 ft. The radiation installed in the barracks is all of the three-column, 38-in. high, cast-iron type. Three or four radiators in a row are connected together at the bottom by a 2-in. pipe, the steam feeding from one radiator into another. One valve controls the three or four radiators that are connected together. A steam main ends at each corner of the barrack and is connected into a steam trap, discharging upon the ground under the building.

The second-story squad rooms are heated by 14 radiators, totaling 810 sq.ft. Using a factor of 88 B.t.u. loss per hour per square foot of glass, 24 B.t.u. for exposed wall and 1.43 B.t.u. loss per hour per cubic foot of contents, these squad rooms would require 762 sq.ft. of radiation to heat them to 70 deg. in weather 10 deg. below zero. The loss through the roof is disregarded, as there is a dead-air space of about 4 in. between the beaver board and the roofing through which the air does not circulate, thus forming a fairly good insulation. The first-story squad room is heated by seven radiators, totaling 385 sq.ft.

The radiation installed in the barracks has been keeping the soldiers comfortable during the cold snaps that have occurred this winter. At night all upper windows in the squad room are opened, and trouble was experienced during the cold weather from radiators freezing. To conserve the water and fuel and prevent freezing, the steam is now turned off the barracks after the soldiers have retired for the night.

Besides the 18 central heating plants there are 42 individual steam-heating plants for officers' quarters and infirmaries, carrying loads of from 280 to 3900 sq.ft. each. These buildings are heated on the two-pipe gravity plan using cast-iron boilers and radiators.

Near the center of the camp is the big amusement zone, which comprises four blocks, 150 x 250 ft., with buildings of a permanent character, having stuccoed fronts. There are theaters, restaurants, dry-goods stores, pool hall, shooting gallery and other buildings which contain a total of 45,000 sq.ft. of radiation. For this zone a two-pipe vacuum heating system is used. Steam is supplied from a central heating plant of 600-hp. capacity, having four 72-in. x 18-ft. return-tubular boilers set in a battery. The other boiler-house equipment consists of one 700-hp. feed-water heater, two 6 x 4 x 6-in. boiler-feed pumps, two 10 x 14 x 12-in. vacuum pumps, one 3000-gal. per hour hot water heater, one 3000-gal. per hour deep-well pump, one 48-in. x 24-ft. pressure tank and one large receiving tank.

Boiler connections of 6 in. diameter lead into a 12-in. drop header. From this two 5-in. leads are taken, each of which passes through a 5 x 10-in. pressure-reducing valve in the boiler house. The 10-in. lines supply heat to the various buildings. No piping is run exposed outside of the buildings. The steam and hot-water supply mains are run in the attics or on the ceilings of the buildings and drop under the streets in wood conduit in a trench back of the buildings.

Builds Small Hydro-Electric Plant

North Wilkesboro, a small town in North Carolina, will soon be operating its own hydro-electric lighting station with a day and night service. The new plant is nearly completed and the only remaining machinery to be installed is the electric apparatus, which has been selected with a view to fulfilling the needs of the city for a long time to come. Although the town has a population of but about 2000, it is setting an example worthy of many others to follow, in that an available water site is being utilized for producing electrical energy.

Heretofore there has been trouble in generating sufficient energy by steam power, which was not only expensive, but could not be generated in quantities sufficient for both day and night service, on account of the scarcity of coal. With the water-power plant in operation the question of coal will be a thing of the past and power will be generated from a source that has been allowed to go to waste day after day, while valuable coal has been burned in producing power that could have just as well have been generated by water.

Forty-seven Coal Dealers Indicted

In response to *Power's* editorial request, in the issue of Feb. 26, for the names of Tennessee operators and dealers indicted for fuel-law violations, a correspondent has sent in a copy of the Knoxville *Journal and Tribune* for Feb. 15, containing a report from which the following is abstracted:

Violations of the Lever fuel control act and price-fixing regulations of the National Fuel Administration are charged in 23 indictments, naming 47 separate defendants and containing 163 counts, which have been returned by the Federal grand jury. Some of the largest coal companies and best known mine operators, wholesalers and retailers of coal in east Tennessee are made defendants. Charges against the defendants include conspiracy to violate the Lever law, filing of false and fraudulent reports with the Federal Trade Commission and the sale of coal at unlawful prices.

Should the defendants be found guilty, they are subject to maximum fines of $5000 on each of the 163 counts, or imprisonment in the United States penitentiary at Atlanta for not exceeding two years, or both fine and imprisonment.

Evidence in the cases was gathered by Arthur J. Delvin, D. H. Littleton, F. S. Shipp and Ernest Hawkins, special agents of the Department of Justice during an investigation which lasted more than two months. Further investigations are to be made, and, if developments justify, the results will be presented to the Federal grand jury which meets in Knoxville on the fourth Monday in May.

John Q. Barker and William C. Barker, of the Barker Lumber Co., coal brokers, of Knoxville, and E. Scott Miles and the Sequatchie Coal Co., coal brokers, of Chattanooga, are named as defendants in an indictment containing 19 counts, one of which alleges conspiracy. John Q. Barker and William C. Barker are made defendants in separate indictments on a charge of having filed false and fraudulent reports with the Federal Trade Commission, reporting the coal handled by them.

The following companies and individuals are named as defendants in an indictment containing 27 counts, two of which allege conspiracy to violate the Lever act: A. Gatliff, T. B. Mahan, E. C. Mahan, N. B. Perkins, L. F. Pratt, C. G. Ellison, N. A. Archer, Gorman Jones, Wiley W. Thomas, J. D. Williams, Southern Coal and Coke Co., New Caryville Coal Co., Sun Coal Co., Gatliff Coal Co., Mahan-Jellico Coal Co., Southern Mining Co., Golden Ash Coal Co.

D. C. Campbell, of the D. C. Campbell Coal Co., is named as defendant in a 14-count indictment, alleging the sale of coal at unlawful prices.

The Superior Coal Co., S. T. Buffet and W. C. Whitaker are named as defendants in a 10-count indictment, alleging the sale of coal at unlawful prices.

The Hackney Coal Co. and Walter M. Miller are named as defendants in an indictment charging the retail sale of coal at unlawful prices.

Hugh B. Miller and Beatrice Hutchens, of the Knoxville Coal Co., are named as defendants in an indictment charging the sale of coal at a retail price of $10.40 per ton when the Government price was not exceeding $6.25.

The Sun Coal Co. is named as defendant in an indictment of 8 counts alleging the sale of coal at unlawful prices.

The New Caryville Coal Co. is named as defendant in a 6-count indictment alleging the sale of coal at unlawful prices.

The Terry, West Coal Co. and A. C. Terry, of Oneida, are named as defendants in a 13-count indictment alleging the sale of coal at unlawful prices.

Tallman Sexton, Clifford Sexton, R. S. Barnes and B. L. Sadler, doing business as the Oneida Coal Exchange, of Oneida, Tenn., are named as defendants in an 11-count indictment alleging the sale of coal at unlawful prices.

The Southern Jellico Coal Co. and Walter L. McKinney, of Jellico, are named as defendants in an 11-count indictment charging the sale of coal at unlawful prices.

Wymer B. Siler, of Jellico, is named as defendant in a 7-count indictment charging the sale of coal at unlawful prices.

Ray Buell, J. L. Lindsay, of Jellico, and Clyde Rhodehaver are named as defendants an indictments charging the sale of coal at unlawful prices.

I. C. Stonecipher, of Scott County, is named as defendant in a 3-count indictment charging the sale of coal at unlawful prices.

W. M. Pierce, of Jellico, is named as defendant in a 3-count indictment charging the sale of coal at unlawful prices.

T. C. Williams, of Jellico, is named as defendant in a 3-count indictment charging the sale of coal at unlawful prices.

John C. Pemberton, of Oneida, is named as defendant in an 18-count indictment charging the sale of coal at unlawful prices.

J. T. Moore, of Jellico, is named as defendant in a 5-count indictment charging the sale of coal at unlawful prices.

These indictments cover a wide field of alleged violations of the Lever act, says District Attorney Kennerly, from conspiracy to violate that law to alleged violations of the prices fixed by President Wilson regarding the sale of coal at wholesale, in car lots, down to small retail sales of from three to five bushels.

Recently, the Federal grand jury at Covington, Ky., returned indictments against 61 coal operators, operating mines and handling coal in eastern Kentucky. Many of these Kentucky defendants, it is claimed, operated in connection with the Knoxville coal brokers and dealers, selling their output, which was marketed through the agency of some of the defendants named in the Knoxville indictments.

How to Join the Army Engineers

The Kaiser has placed the keenest engineering talent of his own and allied empires into the imperial armies of the Central Powers to defeat the world. During these last three years the best engineering skill of France, Great Britain, Russia and Italy and their Allies have been matched against the enemy. American employers are paying engineers such attractive salaries that voluntary enlistments of the high-class technical men in the United States Army are below requirements. This deficiency is also probably due in part to the lack of proper information concerning the engineering branch of the service. Few civilians know that it is possible for them to perform in the Engineering Corps almost exactly the same kind of work in which they are at present engaged.

The best results in any organization are obtained only when the energies of all the men in it are concentrated along the lines for which they are best suited by natural ability, education and training. The First Replacement Regiment of Engineers was organized at Washington Barracks, D. C., on December 14, 1917, with the express idea of accomplishing this end. Its specific purpose is to keep all engineering units of the Army at full enlistment strength during the period of this war. This regiment has not only the responsibility of finding men to fill up depleted ranks, but it must also fit them to step into the work of trained, efficient and disciplined soldiers.

The preliminary work of the recruit is first a thorough training in military drill, for the engineer soldier must be prepared to lay down his shovel and take up his rifle at any time. Infantry drills gradually give way to engineer work and more specific technical training. The engineer soldiers must know how to tie all the important kinds of knots and lashings, to build spar and truss bridges, to construct revetments, dig trenches, place wire entanglements, construct machine-gun emplacements, build pontoon bridges and to construct roads. They must also know the methods of demolition, sapping and mining. Specialized training in lithography, zincography, surveying, mapping, photography, carpentery, blacksmithing, electricity and machinery are also given to those qualified for further training in any of these branches.

The Replacement Regiment will be called upon to furnish men for the following organizations: Camouflage regiments, crane-operating and maintenance regiments, depot detachments, electrical and mechanical regiments, forestry (sawmill) battalions, forestry (auxiliary road, camp and bridge) battalions, gas and flame service, general construction battalions, mining regiments, quarry regiments, sapper regiments, searchlight regiments, supply and shop battalions, surveying, ranging and map-reproduction regiments, water supply companies.

Engineers are called upon to perform such a wide range of work that practically every man with any technical training or mechanical ability can find a place in this organization. Every male citizen in the United States who is physically fit, and between the ages of 18 and 21, and 31 and 40, is eligible to join the regiment by voluntary enlistment.

The applicant should write to the Commanding Officer, First Replacement Regiment Engineers, Room 107, Headquarters Building, Post of Washington Barracks, D. C., for application blank. If the blank shows the man to be eligible, an enlistment card is filled out and sent to the recruiting officer nearest to the applicant's place of residence, with instructions to enlist the man for service in this regiment.

United States Steel and Pig-Iron Output

According to the *Iron Trade Review*, Cleveland, Ohio, the steel-ingot production in 1917, as estimated by the American Iron and Steel Institute, will be 42,600,000 gross tons and the pig-iron output, 38,500,000 tons. The former figure will mark a new record; the latter will mark a drop from the total pig-iron production of 1916. The ability of the steel industry to make a new production record in the year in which the United States entered the war will arouse great satisfaction among the country's friends. Germany's steel output sagged heavily after she opened hostilities, and yet she had a clearer appreciation than any other nation of the colossal tonnages of iron and steel which modern warfare demands. German "efficiency" could round up an immense, trained army overnight, but failed to mobolize simultaneously her industrial forces. America, with an army to find and equip, and with the handicaps which her inexperience and unpreparedness entailed, was able, at the same time, the *Review* states, to keep her steel furnaces in operation and to surpass her 1916 mark, itself a record. The decline in pig-iron output from 1916 is comparatively slight and is due to the difficulties met in assembling raw materials. The *Review* concludes by stating that the year's record production inspires confidence in the future. Germany's steel industry, when pitted against America's, is fighting a losing battle.

Signal Corps Wants Electrical Men

The Signal Corps, U. S. Army, has announced that it can use the services of a large number of men having electrical training. They are needed especially in connection with the radio communication systems in use in the military service. All classes of electrical men—wiremen, expert electricians, storage-battery men, telegraph and wireless operators, and men with electrical-engineering training and experience are wanted. The opportunity offered is exceptional because of the great interest and importance of this branch of the service which has been most aptly characterized as the nerve system of the army. Men engaged in the radio division of the communication work in particular have an increasingly important part in the great intelligence system upon which army operations are almost totally dependent. The scope of this work requires men who will fall in general into three classes, depending on the character and amount of experience had by the individual; namely, radio operators, radio mechanics and field radio experts.

Application blanks for service in the radio work of the Signal Corps may be secured by addressing the Office of the Chief Signal Officer, Land Division, Training Section, Washington, D. C. Men of draft age may make application and if qualified will be inducted into the army, at their request, for service in this branch of the Signal Corps. After enlistment or induction, all personnel will be sent to one of several radio schools for six weeks to three months of intensive training in one of the three general branches of the radio work for which their previous experience qualifies them. Some of the personnel completing these courses will be commissioned, and the opportunity for advancement for all graduates will be dependent on the individual ability.

Comparative Costs of Heating by Electricity, Gas and Coal

The following examples will give one an opportunity to determine the comparative costs of heating a building by electricity, gas, hard coal, and soft coal, by employing the figures or costs of fuels in his own locality.

The heating value of one kilowatt-hour is approximately 3400 thermal units—therefore, at 10c. per kw.-hr., one cent will purchase 340 thermal units. At $7.50 per ton hard coal—making available about 8000 thermal units per pound—one cent will purchase 21,333 thermal units. At this rate it would cost 62$\frac{7}{10}$ times as much to heat with electricity as with coal.

The available heating value of one cubic foot of gas for heating purposes is approximately 600 thermal units per cubic foot. At 50c. per 1000 cu.ft., one cent would purchase 12,000 thermal units. With coal at $7.50 per ton—it would cost 1$\frac{7}{10}$ times as much to heat with gas as with hard coal.

With electricity and gas on the same basis—but with soft coal—having a heating value of 6000 thermal units per pound and selling at $3.50 per ton—it would cost one hundred times as much to heat with electricity as with soft coal—and 2$\frac{3}{10}$ times as much to heat with gas as with soft coal.—*The Ideal Fitter.*

Obituary

John P. Sparrow, chief engineer New York Edison Co., died suddenly of pneumonia at his home, Sunday, Mar. 17. A full account of Mr. Sparrow's career is now being prepared and will appear in our next issue.

Personals

Harry S. Potter has resigned as general manager of the Tarentum Glass Co. to become general manager of the Wellington Glass Co., Cumberland, Md.

C. W. Watkins, of Dorranceton, Penn., inventor and patentee of the Watkins automatic air-regulating furnace door, has sold his United States patent rights on the device to the Page Boiler Co., of Chicago, Ill.

Miscellaneous News

Launch Big Concrete Ship—The world's largest concrete ship, 7900 tons, christened the "Faith," was launched at a Pacific port Mar. 15. With the successful completion of the ship the construction of 54 similar vessels will start, according to her builders. The "Faith" was launched six weeks after the concrete was poured into the forms.

Fifty-eight Electric Companies operating in Pennsylvania have filed notices with the Public Service Commission that they propose to advance rates since Jan. 1. In every instance the advances are declared to be necessary because of increased cost of fuel, labor and materials. In a number of cases objections have been filed and hearings held. In the same period there have been notices of increases filed by 24 gas companies, while 20 telephone companies, most of them rural lines doing a purely local business, have given notice of advances in rates.

Stevens Institute Commencement—As many members of the senior class have been pursuing an accelerated schedule since Nov. 21, 1917, the graduating exercises this year will be advanced from June 11 to Apr. 2, as follows: Saturday, Mar. 30, 8 p.m., alumni smoker; Sunday, Mar. 31, 7:45 p.m., baccalaureate sermon. Tuesday, Apr. 2, 10:30 a.m., forty-sixth annual commencement in the auditorium; 1 p.m., President and Mrs. Humphreys' reception to the graduating class, trustees, faculty, alumni, undergraduates and friends at Castle Stevens; 3:30 p.m., review of Stevens Battalion under command of Francis G. Hubbard, First Lieutenant, 71st Infantry, N. Y. G., drillmaster, by President Humphreys and graduating class.

Business Items

The Wilson-Snyder Manufacturing Co., of Pittsburgh, Penn., has opened an office in Cleveland, Ohio, at 511 Citizens Bldg., with H. W. Van Cleve, of the Pittsburgh office, in charge as district manager.

The D. Connelly Boiler Co., of Cleveland, has awarded contracts for an addition to its main boiler shop. The addition will be 140 x 80 ft. of steel construction and glass. This company is installing a set of plate-bending rolls which are said to exceed in length and capacity any similar machine in any boiler-manufacturing plant in America.

The Dingle-Clark Co. has been organized with offices at 536 Engineers Bldg., Cleveland, Ohio. This corporation will handle a complete line of motors, transformers, controllers, turbo-gears and is in a position to install electrical equipment for any size plant. Howard Dingle and W. W. Clark were, up to Feb. 1, respectively district manager and assistant manager of the Crocker-Wheeler Co. in Cleveland. Both are well known in Ohio electrical circles by reason of their ten-year connection in this territory.

William T. Price resigned as manager and chief engineer of the De La Vergne Machine Co.'s oil-engine department recently to become president of the P-R Engine Co., of New York, and second vice president of the Rathbun-Jones Engineering Co., of Toledo, which will undertake the sale and manufacture respectively of Price-Rathbun stationary and marine oil engines built in accordance with a new principle of fuel injection developed by Mr. Price during the past several years. The P-R Engine Co. has its main office at 110 West 40th St., New York, and branch offices in Philadelphia, Baltimore and Toledo.

NEW CONSTRUCTION

Proposed Work

N. J., Jersey City—The Hudson County Boulevard Commissioners will receive bids until April 3 for equipment for the lighting system of the Hudson County Boulevard. E. Cahill, Pres.

N. J., Pitman—The Electric Co. of New Jersey has been granted permission by the Board of Public Utilities, to issue $197,000 bonds; the proceeds will be used to build additions and make improvements to its plant. W. P. Mercer, Mgr.

Penn., Clifton Heights—The Kent Manufacturing Co. has had plans prepared for the erection of a power plant and boiler house. Estimated cost, $50,000. F. E. Hahn, Arch., 1112 Chestnut St., Philadelphia, is receiving bids for the construction. Noted Jan. 29.

Penn., Waynesboro—The Greencastle and Waynesboro Ry. Co., Bank Bldg., is having plans prepared for the erection of a 2 story, 40 x 50 ft. substation. Estimated cost, $10,000. H. D. Sefton, Gen. Mgr.

Md., Linthicum—The Consolidated Gas Electric Light and Power Co., Lexington St. Bldg., Baltimore, will soon award the contract for the erection of a 26 x 40 ft. addition to its power station. Estimated cost, $7000. E. D. Edmonton, Baltimore, Gen. Supt.

N. C., Dunn—The General Utility Co. recently incorporated with $100,000 capital stock, plans to build an electric lighting plant. Estimated cost, $25,000.

N. C., Warrenton—The Warrenton Electric Light Co. plans to build a 3 phase, 2200 volt transmission system. J. M. King, Mgr.

Ga., Elberton—City plans to extend its electric lighting system. S. W. Allen, Gen. Supt.

Fla., Daytona—The Daytona Public Service Co. plans to increase its capital stock from $300,000 to $500,000; the proceeds will be used for additions and improvements to its system. R. W. Messmore, Ch. Engr.

La., Shreveport—The Elliott Electric Co. is considering the installation of additional equipment.

Ky., Graham—The W. G. Duncan Coal Co., Greenville, will build a 75 x 100 ft., brick and concrete power house. The work will be done by day labor. C. M. Means, Oliver Bldg., Pittsburgh, Pa., Consult. Engr

Ky., Newport—The Newport Rolling Mill Co. has acquired a site here and plans to build 11 additional sheet mills and install new machinery including a 6000 kw. generator set to operate proposed mills. Estimated cost, $500,000. W. A. Andrews, Pres.

Ohio, Middleport—The Staltee-Essex Coal Co. plans to install electrical equipment in its mine. F. Essex, Supt.

Ohio, New Petersburg—Fred Essex plans to install electrical equipment in his mine.

Ill., Charleston—City plans to issue $20,000 bonds to improve its electric lighting and water works systems. Address T. T. Shoemaker.

Ill., Rockford—City election in April to vote on $500,000 bonds for the erection of an electric lighting plant. E. A. Wittergren, City Clerk.

Wis., Reedsburg—City plans to improve its electric lighting plant and install new machinery including electrical generating unit of 250 or 300 kw. directly connected to either uniflow engine or steam turbine. O. W. Burkett, Gen. Supt.

Wis., Thorp—The Thorp Electric Light and Power Co., recently incorporated plans to take over the City electric lighting plant and improve and enlarge same. P. D. Kline, interested.

Iowa, Dysart—The Iowa Ry. and Light Co. plans to install a high tension line from here to Traer. W. G. Dows, Cedar Rapids, Gen. Mgr.

Kan., Colby—City plans to build a transmission line from here to Oakley. C. V. Parrott, City Clerk.

Kan., Gardner—City plans to build an electric lighting plant. Estimated cost, $20,000.

Neb., Carroll—Village voted $9500 bonds to install a lighting system.

Neb., Schuyler—City election April 2 to vote on $40,000 bonds to build an electric lighting plant. E. A. Schmid, Mgr.

Okla., Stillwater—City voted $175,000 bonds for improvements and additions to its electric lighting plant. G. M. Smith, Supt. Noted Mar. 5.

N. M., Gallup—The Town Board plans an election to vote on propostion to build an electric lighting plant. K. H. Myers, Secy.

Wash., Walville—The Central Light and Manufacturing Co. has filed a petition with the Lewis County Commissioners, for authorization to build an electric light and power line from here to Meskill. R. P. Brush, Pe Ell, Supt.

Calif., Bakersfield—The Mt. Whitney Power Co. of Bakersfield, plans to spend $108,562 to improve and enlarge its hydro-electric generating plants and $216,937 to extend distributing lines in Tulare, Kern and Kings Counties. E. R. Davis, 624 Pacific Electric Bldg., Los Angeles, Mgr.

Ont., Armagh—The Armagh Electric Co. receives bids in April for electrical equipment for power development. Estimated cost, $40,000.

Ont., Cornwall—The Cedar Rapids Transmission Co. has had plans prepared for the erection of a 110,000 volt station.

Ont., London—The City will appropriate $25,000 for extensions to its electric lighting plant.

Ont., Rideau—The Hudro Electric Commission plans to purchase High Falls on the Mississippi River and build a generating station on same.

B. C., South Wellington—The Canadian Collieries are in the market for boilers and air compressors to install in the mines.

CONTRACTS AWARDED

N. J., Hoboken—The Board of Education has awarded the contract for installing electrical fixtures and lighting system in Public School No. 3, to W. Coleman, 29 Willow Court, Jersey City. Estimated cost, $15,000.

N. J., Jersey City—The Board of Education has awarded the contract for installing electrical fixtures and lighting system in Lincoln High School on Harrison Ave., to W. Coleman, 29 Willow Court. Estimated cost, $21,000.

N. J., Perth Amboy—The American Smelting and Refining Co. has awarded the contract for a 1 story, 60 x 70 ft. addition to its power house to be erected on Maurer St., to I. Crouse, 495 State St. Noted Oct 23.

Penn., Philadelphia (Kensington)—L. S. Leberman has awarded the contract for a 1 story, 30 x 40 ft. power house addition and a new boiler house, to Conneen Constr. Co., 1737 Filbert St. Noted Feb. 26.

D. C., Wash.—The U. S. Government has awarded the contract for electric lighting system in Anacostia, to the G. E. Engineering Co., 417 Canal St., New York City. Estimated cost, $10,535.

Tenn., Hadleys Bend—The U. S. Government has awarded the contract for furnishing electrical equipment for the proposed power plant, to the West Electric Co. Estimated cost, $5,000,000.

Ohio, Cleveland—City has awarded the contract for an addition to its electric lighting plant on East 53rd St., to Kelley Demarest Constr. Co., 418 American Trust Bldg. Estimated cost, $25,000. City is constantly purchasing machinery and equipment and will soon be in the market for all kinds of boilers, generators, switchboards and equipment. W. E. Davis, Ch. Engr.

Mich., River Rouge—The Ford Motor Co. has awarded the contract for a 1 story, 40 x 60 ft. transformer house to be erected on Dix Rd. and River Rouge, to H. G. Christman Co., Stevens Bldg., Detroit.

Ill., Great Lakes—The U. S. Government has awarded the contract for an addition to the overhead distribution and lighting system at the Naval Training Station, to Paxchen Bros., 111 West Washington St., Chicago. Estimated cost, $7830.

Mo., Carthage—The Polak Steel Co., Cincinnati, Ohio, has awarded the contract for an addition to its power plant here, to M. Marcus Building Co., 2023 Reading St., Cincinnati, Ohio.

Wash., Puget Sound (Bremerton P. O.)—The U. S. Government has awarded the contract for a telephone and transmission line, to Nepage & McKenny, Armour Bldg., Seattle. Estimated cost, $8950.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1] Mar. 21, 1918	Individual[1] Mar. 21, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	.....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1] Mar. 21, 1918	Individual[1] Mar. 21, 1918
Pea	$5.05	$5.80
Buckwheat	4.30—5.00	5.50—5.80
Barley	3.25—3.50	4.00—4.25
Rice	3.75—3.95	4.50—4.80
Boiler	3.50—3.75	.....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Mar. 21, 1918	One Yr. Ago	Mar. 21, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.05	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties Mar. 21, 1918	Mt. Olive & Staunton Mar. 21, 1918	Standard Mar. 21, 1918
6-in. lump	$2.65-2.80	$2.65-2.80	$2.65-2.80
2-in.-lump	2.65-2.80	2.65-2.80	2.65-2.80
Steam egg	2.65-2.80	2.65-2.80	2.65-2.80
Mine-run	2.40-2.55	2.40-2.55	2.40-2.55
No. 1 nut	2.65-2.80	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.30	2.15-2.30	2.50-2.65
No. 5 washed	2.15-2.30	2.15-2.30	2.50-2.65

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.